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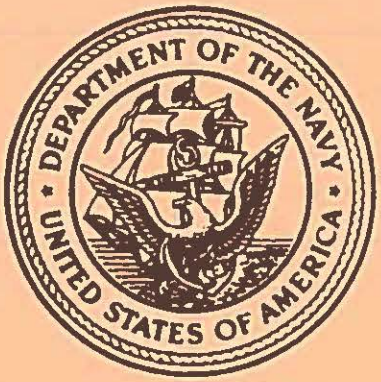

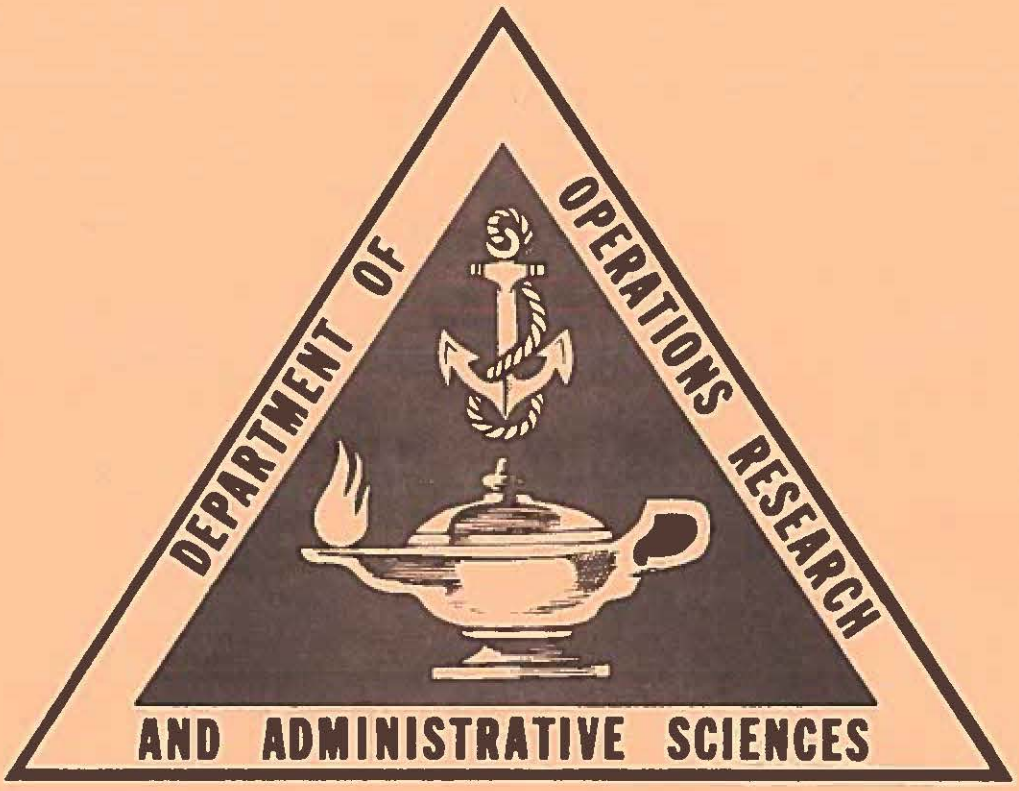

MANAGEMENT QUARTERLY

NAVAL POSTGRADUATE SCHOOL

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DEPARTMENT OF
OPERATIONS RESEARCH AND
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MANAGEMENT QUARTERLY

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Editorial

This edition of the Management Quarterly, is a continuation of a student project initiated in the Fourth Quarter, 1968-1969 Academic Year.

In selecting material for each edition of the Management Quarterly, the editorial staff solicits various professors in the Operations Research and Administrative Sciences curricula for student academic efforts that, in their opinion, display excellence in terms of originality, literary ability, and well documented research. Therefore, it is quite reasonable to expect a very broad scope of potential material to be considered and in fact, there is consistently a wealth of student papers which must be reviewed, screened and selected for publication each quarter.

Prior to selecting any student papers for publication in this issue, we, the editors endeavored to "define" who the typical reader of the Management Quarterly is and what criteria we should use to select articles for him to read. In our opinion, the typical reader is a busy student, who has little time for reading outside his studies and who will reject any extracurricular articles he considers too "dry and stuffy." Therefore, in order to meet his needs and the objectives of the Management Quarterly we used the following criteria in our selection of student papers for publication.

First, they had to be easy to read. We felt the reader should be able to read the article without spending a great deal of time or effort at it.

Second, the papers had to be timely and interesting. We recognized that this was a formidable requirement because of the large number of readers with extremely diverse interests and backgrounds.

Third, the papers must inform the reader, adding to his professional knowledge and managerial ability. They should be challenging and thought provoking, providing the reader with new ideas and alternative solutions to professional and managerial problems.

Using these criteria we have formulated this edition from a large number of papers dealing with many subject areas. We feel the papers of this issue are readable, interesting, and informative and we hope that you agree.

The views expressed in the papers selected for publication in this edition of the Management Quarterly are those of the authors exclusively and in no way reflect the attitude or endorsement of the Defense Department, Navy Department, or the Naval Postgraduate School.

Naval Air Systems Command:

Program Management

By F.D. Schwikert

Recently a great deal of attention has been focused upon program management. It has been touted as the solution to the successful development of complex weapons systems. This paper gives the reader an introduction into the organizational concepts of program management as exercised in the Naval Systems Command.

This paper was submitted to Commander Benedicktsson for Behavioral Science in Management (OS•350l)

Introduction:

Birth of Program Management

Technological advances during the past decade have progressed at an accelerated rate.

> "Considering that the annual national R&D budget in the United States is larger than the total budget used to run medium-sized nations, it is no exageration that R&D is an emmense apparatus. . .Of every eight scientists who ever lived seven are alive today." (5:9)

As science continues to progress, the effects of increased technology will continue to complicate the weapons systems of the Navy. State-of-the-art development of a weapon system leads to quicker obsolescence of existing systems.

Lieutenant F.D. Schwikert, U.S. Navy, received his B.S. degree from Georgia Tech in l967, and received his M.S. degree in Aeronautical Engineering from the Naval Postgraduate School in l975.

> "The rapid advancing technology has taxed man's organizational and administrative abilities. As major scientific projects become more complex, the problems of management increase greatly." (7:134)

It is the complexity of today's weapons systems that has lead to the development of a dynamic new form of management.

> "The development and production of a major defense system shall be manned by a single individual (program manager) who shall have a charter which provides sufficient authority to accomplish recognized program objectives." (4:1)

This policy set forth by the Deputy Secretary of Defense, the Honorable David Packard, is the origin of program management in the Department of Defense. In response to this policy, the Naval Air Systems Command has set up program management offices to manage its major weapon systems.

NAVAL AIR SYSTEMS COMMAND ORGANIZATION:

Functional Support

Organization by function is based on specialization and division of labor. It is the most common organization form. A function is an action or activity which supports or is a part of a larger organization. The Naval Air Systems Command is made up of six such functional departments. Each department is sub-divided into divisions and further into branches.

These functional groups are much like those conceived by Max Weber, the German sociologist, who studied organizations in the early part of the twentieth century. He felt that man was the unpredictable element in an organization. To minimize his impact on the organization a well-defined hierarchy of authority must be established. To capitalize on specialized skills Weber also advocated division of labor based upon functional specialization. (7:58-9) These features are incorporated into the Naval Air Systems Command functional departments. Personnel are assigned into divisions

based upon their functional skills and well-defined chains of command are maintained.

Air 5332 is responsible solely for development, test, evaluation and production engineering of air-launched missile internal guidance, control and electrical power supply sub-systems, internal telemetry and intercept instrumentation, guidance-activated fuzing sub-systems and associated test equipment therefor. This highly specialized function is their sole area of responsibility. The same degree of specialization is essentially true for the other branches. (9:533)

Purely functional organizations provide flexibility and versatility in the utilization of manpower. Personnel can be used on many different projects. By grouping specialists in this fashion, knowledge and experience attained from one project can yield benefits to others. Basically, it can be stated that through functional organization, the Naval Air Systems Command has maintained a broad manpower base which exhibits continuity from one project to another. Thus, as the Missile Guidance and Control Branch transitions from project to project a greater degree of knowledge and experience of missile guidance and control is attained.

Program Management

Although the functional approach to management provides for flexible use of manpower, the Department of Defense recognized a major disadvantage of functional organizations operating alone. (6:8) It does not provide the program oriented emphasis necessary to the accomplishment of today's complex projects. No one individual is responsible for the total project.

> "In bureaucratic organizations people tend to become self-centered avoiding responsibility wherever possible. They find it easier to fall in line with easy-to-understand rules instead of being inspired by the larger objectives of the organization." (1:17)

There also exists a tendency for functional managers to set standards of performance. These standards are often used solely to perpetuate the existance of the organization.

> "The function form has important advantages, but some actual implementations become limiting. Too narrow a functional outlook tends to create little empires within the organization. Overall objectives become obscured, and defense mechanisms develop to promote a particular function into an independent entity instead of part of the entire process." (8:53)

These problems associated with functional specialists are not new.

> "The expert, in fact, simply by reason of his immersion in a routine, tends to lack flexibility of mind once he approaches the margins of his special theme. He is incapable of rapid adaptation to novel situations. He unduly discounts experience which does not tally with his own. He is hostile to views which are not set out in terms he has been accustomed to handle. No man is so adept at realizing difficulties within the field that he knows; but also, few are so incapable of meeting situations outside that field. Specialism seems to breed a horror of unwonted experiment, a weakness in achieving adaptability, both of which make the expert of dubious value when he is in supreme command of a situation." (12:92)

Another problem associated with functional specialists is the tendency to see their discipline as the focal point of program success. In order to reconcile these problems, program management was introduced into the Naval Air Systems Command. The concept of program management is to develop, in a single individual, sole line authority and responsibility for the accomplishment of the specified program objectives. The program manager must then direct the development of systems in such a manner as to meet the performance, cost and schedule objectives which are defined by his Service. In essence, the program manager is required to draw the authority and responsibility of the parent Service for the successful running of the program. By concentrating his full

attention on the accomplishment of his program objectives, he becomes the major force drawing the program towards successful completion.

> "Recently, a panel of military program managers examining their role likened it to that of the general manager of a small company. The comparison is especially apt. It would be impossible to write a meaningful position description for that job. It is equally impossible to write one for the program manager's job. What the general manager does is whatever is needed to move the affairs of the business. He does one thing at one time and another thing at another time -- whatever is most needed at the moment to achieve his objectives. A general manager is not a doer of any job -- there are other managers charged with the doing. But the general manager sees to it that what he wants done, and his objectives are achieved. The role implies reliance on others to do the work; but it also implies controlling and coordinating the work so that no one aspect dominates others to the detriment of the harmony of the whole." (6:4)

Here we see the basic framework of organization in the Naval Air Systems Command. The Assistant Commands are the "doers" and the program offices act as the general managers who are tasked with the harmony of the whole.

Criteria for Program Management

It would be impractical to assume that the concept of program management could be applied to all programs. The benefits derived from program management must be weighed against the extra cost and manpower involved in the installation of a program office. Consequently, the Department of Defense has established three basic criteria for the establishment of program management.

1. High dollar value (programs which have estimated research and development, testing and engineering costs in excess of fifty million dollars, or an estimated production cost in excess of two hundred million dollars).

2. National urgency.

3. Recommendations by Department of Defense Component Heads or Office of the Secretary of Defense (OSD) Officials.

In addition, program management can be established for programs that involved a high degree of organizational complexity or technical involvement. (4:1)

NAVAL AIR SYSTEMS COMMAND PROGRAM MANAGEMENT:

Program Office

Naval Air Systems Command program offices are typically small centralized management groups. They are served by the functional groups which are responsible to the program office for the execution of assigned tasks. This environment, where resources for mission accomplishment are located exterior to the managing authority, could be a source of conflict. Again, functional specialists tend to see their area of concern as paramount to the success of the program. In order to eliminate this tendency, program offices in the Naval Air Systems Command are given specific charters under which to operate. The program charter bestows the authority upon the program manager to accomplish the objectives of his charter.

In order to understand the need for authority, it is necessary to examine the responsibilities of a program manager.

> "The program manager is involved in the definition, development, testing and evaluation, acquisition and initial support of the system in response to operational requirements. This includes various sub-systems and components, spare and repair parts, peculiar ground support and test equipment, training equipment and all supporting technical documentation." (10:2)

To adequately direct an effort of this magnitude, a program manager must be established early in the development cycle. However, early establishment is not the sole requirement. In order to assure the success of a weapon system, a program

manager's involvement must begin early in the development cycle and last through initial introduction to the fleet.

In order that a program manager can effectively direct a responsibility of this magnitude, a great deal of authority must be delegated to him. The vehicle of this authority is the program manager's charter.

Executive Authorities of a Project Manager

1. The authority to make the necessary technical and business management decisions on all matters within the scope of their Project charters, other than those business decisions for which the Contracting Officer is responsible under ASPR and Departmental procedures.

2. The authority to exercise control over all resources approved in the Five Year Defense Plan and authorized for obligation in allocations.

3. The authority to establish work tasks, establish schedules for work accomplishment, approve cost estimates and Procurement Requests.

4. The authority to issue under the Project Manager's own signature such correspondence, technical directives, planning directives, management plans, instructions and allocations as may be necessary to ensure that his Project is properly managed.

5. The authority to establish direct communication channels with participants in his Project.

6. The authority to plan, organize and administer his immediate Project Management Office.

7. The authority to prepare and sign efficiency reports on civilian personnel assigned to his immediate Project Management Office.

8. The authority to prepare and sign fitness reports of military personnel assigned to his immediate Project Management Office.

9. The authority to appeal any decision of a Data Review Board or an Engineering Change Control Board to his Chartering Authority.

10. The authority to appeal any decision by a Contracting Officer to his Chartering Authority. (11:6)

Although the program managers typically are lower in rank than the Assistant Commanders of the Naval Air System Command, they enjoy a direct command line to the Commander. Consequently the authority of a program manager is commensurate with the responsibility associated in the management of the program. Although the Naval Air Systems Command program manager's charter is well defined, and his authority clear cut, his utilization of the concepts of program management is by no means routine.

> "Military program managers should be free to exercise judgement...He must decide for himself what methods, techniques and systems he will use." (6:6)

Use of Program Management

Introducing the concept of program management, the Naval Air Systems Command has attained the means to manage the development of its complex weapon systems. To see how program management is applied, it is necessary to examine a typical program office and describe its relation to the rest of the command.

When a requirement for a weapon system is established that meets the necessary thresholds of cost, urgency or complexity, the Commander issues a 5400 series instruction. This instruction established a program under the direction of the Commander Naval Air Systems Command. It assigns the program manager by name and promulgates his charter. This charter provides the program scope, operating relationships, organizations and resources, and deligates the authority and responsibility of the program manager. Normally background information leading to the establishment of the program office is given. (10:1)

Once the charter is issued and the program office staffed, it is the responsibility of the program manager to execute the "cradle-to-grave" objectives of the charter. A typical program office will be staffed with less than ten people. With this small allocation of manpower, the dependence upon functional groups can readily be seen. The program manager must accomplish his defined goals through the use of personnel in the functional structure of the Assistant Commanders. He draws up the specialized skills of particular functional branches as required. For example, a program office may be responsible for the procurement of a major weapon system. One of the requirements of this

weapon system could be a sophisticated radar. The requirement for the development of the radar system would be delegated to a functional group. In this case, Air-5333, the Radar and Tactical Control Branch. The program office would set the requirements for the radar system to assure compatibility with the entire system, but the radar branch would actually develop the system.

In this manner the program manager reaches out cutting across functional lines for the accomplishment of his specific objectives. This type of management has the advantage of horizontal and diagonal relationships. In such an organization, managers and technicians deal horizontally with peers. To follow the chain of command would be unwieldy, time consuming and costly, and would disrupt and delay work.

Another, and perhaps the greatest, advantage associated with this type of management is its ability to view a program through a systems approach. Again let us refer to the development of a weapon system which requires a radar system. By tasking a program manager with the responsibility of the development of a weapon system, there is assurance that the radar system will be compatible with the rest of the weapon system. Because of their high degree of specialization, the Radar Branch working independently may not be able to achieve system compatibility.

On the other hand, the necessity to work through functional groups provides the checks and balances required to develop weapon systems.

> "The project manager does not have unilateral authority in the project effort; he frequently negotiates with the functional manager. These negotiations provide an opportunity to achieve trade-offs between project performance, delivery, and cost objectives." (2:230)

It is through this use of program management that the Naval Air Systems Command is able to successfully manage complex weapon systems.

THE FUTURE OF PROGRAM MANAGEMENT:

Criticism of Program Management

Since its inception, program management has fallen prey to severe criticism. Much of this criticism is from the functional managers who feel the program managers are usurping functional authority. This attitude stems from a lack of understanding of the concept of program management.

> "One major difficulty on managerial personnel in adjusting to the concept of project management is their failure to understand its derivation." (3:2)

As time progresses and functional managers learn that program management is not a threat to their existence, then the interface between program manager and functional manager will become more harmonious.

Another criticism raised by functional managers concerns the application of manpower resources. As more and more programs are established, more requirements are passed on to the functional managers. The functional groups, however, usually operate at fixed personnel levels. This means that programs begin to compete for the best personnel in the functional groups. The solution to this problem, while very apparent, is not readily attainable. As development and manpower costs continue to rise, operating budgets do not. Given a fixed amount of personnel, the more programs they are required to participate in, the less time they can spend on any one program. Although not desirable, this situation is sometimes necessary.

Key to Success

The final point to be raised in the future of program management concerns the program manager himself. If we expect the development of highly sophisticated weapon systems to be successful, then we must insure that the main ingredient to this success is present. It is not enough to merely appoint a program manager.

> "An individual placed in the position of a project manager will find little literature to clarify his role..." (2:158)

Only by establishing high quality standards and providing adequate training for program managers can we expect program management to continue to be the effective tool it is in the development of complex weapon systems.

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The Merchant Marine Impact On Economic And National Security

By Vernon D. Stocker

The U.S. flag merchant marine industry has been a victim of lack of foresight, inflation, and crisis management. U.S. trade is predominantly in the hands of foreign carriers. This paper discusses the current state of the U.S. flag merchant marine fleet and its impact on U.S. economic and national security.

This paper was submitted to Commander Benediktsson for Transportation Management (MN 3373).

Problem: U.S. trade is predominatly in the hands of foreign carriers, posing a threat to both economic and governmental controls:

In 1946, the United States flag merchant fleet was the largest and finest in the world. Now it is seventh in ranking, far from the newest of fleets, and committed to carrying only five percent of total U.S. cargo tonnage. Bulk vessels carry an even smaller two percent of the cargo available to their class. U.S. liner cargoes, despite operating subsidies from the federal government, exhibit a similar, steadily deteriorating state of affairs.[1]

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[1]Hall, P., "A Union Leader Looks at the Merchant Marine," U.S. Naval Institute Proceedings, May 1974, p. 182.

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It has been said that international sea commerce is a zero-sum game in many respects. There is a given amount of ocean freight to be hauled over the earth's surface. A number of nations which serve as suppliers for U.S. critical materials recognize the value of leverage in obtaining a share of the essential seaborne trade, particularly for their indigenous exports. The trend of late has witnessed significant efforts by Middle Eastern and South American oil producing nations to mandate all export cargo for their own up-and-coming fleets of flag ships. Iraq, Egypt, Libya, and Syria have announced plans for significant new tanker construction projects. The more important oil exporters from our point of view -- Venezuela, Kuwait, and Saudi Arabia -- have similar goals.[2]

In June, 1969, a Soviet cargo ship entered the port of Seattle carrying 900 tons of titanium -- an essential metal for aircraft production. Eighteen months later, another Soviet freighter docked in Los Angeles with a load of steel and general cargo from Japan. The Far Eastern Steamship Company (FESCO), a Soviet government-owned corporation operating out of Vladivostok, thus commenced penetration of U.S. trade by providing "third flag" service to our Pacific Coast ports. 136,000 tons moved in this manner from Japan during 1970, and an additional 87,000 tons during the first six months of 1971. The first of three vessels in FESCO's new full container service departed Long Beach in September 1972 with an enroute stop in Oakland and final destination Hong Kong.[3]

Western world shippers express increasing concern that a continued Soviet gain in merchant marine trade will drive private shipowners (and marginal operators) out of business, unless further government subsidies and other forms of assistance are rapidly forthcoming. The facts are these: the Soviet's massive shipbuilding program enabled their merchant marine fleet to surpass the U.S. fleet in tonnage in 1973, coincidentally doubling our statistics in numbers of ships as well. The Soviet merchant fleet also carries roughly 50 percent of that nation's own cargoes at the present time -- a firmly established tradition for many major maritime nations. Current projections indicate that

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[2]Ibid., p. 181.

[3]Editor, "Third Flag Rate Cuts," Sea Power, August 1974, p. 26.

despite the impetus provided by our Merchant Marine Act of 1970, the USSR will have 23 million deadweight tons of available shipping in comparison to an anticipated 15.5 million deadweight tons for the U.S. in the year 1980.[4]

In addition to our chief rival for control of the oceans commercially and militarily, we are also outweighed by the private flag-of-convenience fleets of Liberia, Norway, Britain and Japan. Other countries such as Greece are vying for elevated rank in the shipping circle. Let us couple this thought with the noteworthy fact that U.S. dependence on foreign raw materials has grown dramatically in the last decade. The following table[5] is a list of essential raw material imports for which we presently have no suitable domestic substitute in terms of minerals and/or quantities:

Raw Material	Percent of U.S. Consumption Imported
Tin	100
Rubber	100
Cobalt	100
Chromite	100
Manganese Ore	99
Nickel	88
Bauxite	87
Asbestos	85
Lead	44
Petroleum	33
Iron Ore	32

We also depend on foreign processing services for refining oil and liquifying gas. Furthermore, some U.S. based "multi-national" corporations, such as in the electronics industry, have moved their manufacturing enterprises abroad, subsequently exporting back to the continental U.S. its essential but sophisticated equipments for both the civilian and military sectors.

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[4] Loc. cit.

[5] Hall, op. cit., p. 181.

A collateral but very closely related issue is the concept of an "effective U.S. control" (EUSC) fleet during times of national emergency. The peacetime or cold war trade environment points to an already scarce supply of U.S. shipping bottoms for our own imports/exports. The EUSC doctrine of control is based upon contracts or agreements between the federal government and owners of flags-of-convenience vessels. When national security is at stake, in terms of an emergency proclaimed by the President, an unmodified section of the Merchant Marine Act of 1936 gives the government the authority to requisition or purchase any vessels owned by citizens of the United States, regardless of flag registry. Typically, such ships fly the flags of Panama, Liberia, and less frequently, Honduras (the so-called PanHonLib flags). Foreign citizens also operate some of the ships in the EUSC fleet.

The Maritime Administration carries out the effective control principle through one or a combination of four types of agreements[6] with ship operators:

1. Contracts derived from the trade-out-and-build program, where the United States permitted the sale or transfer of certain flag vessels in 1956 to foreign registry provided that new ships would be built in American yards to replace transferred ones and that all such vessels would be subject to the emergency requisition procedures of the 1936 Merchant Marine Act.

2. Direct or indirect U.S. citizen ownership, in which we reserve the right to acquire privately-owned property in the interests of national defense. This means that the Republics of Liberia and Panama would be expected to acquiesce in the face of a specific takeover of their flag fleets, solely to oblige the effective control concept.

3. War risk insurance, or interim insurance policies provided by the federal government to cover shipowners for a 30-day period after the outbreak of a war involving the major world powers. Since most commercial insurance policies would be void in an international conflict, the war risk insurance program has successfully attracted many shipowners willing to make their vessels available to the U.S. government in return for financial security in a critical period.

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[6]Emery, S.W., "U.S. Effective Control Fleet," U.S. Naval Institute Proceedings, May 1970, p. 174.

4. Letters of intent, considered the least reliable of the four agreements, are written statements to the Maritime Administration from commercial operators and owners that their ships will be placed under U.S. disposition in an emergency. Such representations come about through the unilateral good faith of the signers, and nothing more.

The presumption that EUSC ships will be available in a crisis is a major U.S. mobilization planning factor. The strategy of EUSC places tremendous confidence in agreements which are of less than treaty significance, and with the exception of war risk insurance, there is an abiding trust in shipowners/operators acting in consonance with U.S. aims vice commercial interests or the desires of the countries of registry.

Since EUSC is an untested concept, objections[7] to the program are many and diffuse: indisputable control of foreign-registered and foreign-manned ships cannot be assured (as already mentioned); the "balance" of the EUSC fleet, with a great many large and specialized oil and bulk carriers, does not include a sufficient inventory of "clean" tankers to carry exotic aviation and ship fuels used by the U.S. military; foreign-built ships lack many national defense features incorporated in U.S. built ships (items 100% funded by MARAD at the time of construction, I might add); foreign crews might be unwilling to man EUSC ships during wartime operations; and finally, the disruption of EUSC fleet foreign trade patterns might cause devastating economic and political repercussions for both allied and neutral nations.

To gain an approximate idea of U.S. flag fleet (privately-owned) and EUSC fleet compositions, the reader is invited to examine Appendix One.[8]

In summary, the United States finds no economic or national security in its present flag merchant shipping. The image of the merchant marine as a small but competent peace-time industry with the capability of rapid expansion in an emergency is an outmoded concept. We have only recently embarked on a new shipbuilding program to satisfy domestic goals. Future military conflicts will most certainly depend on an off-the-shelf merchant marine....not on a head-long

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[7]Kasputys, J.W. and J.B. Young, "Subsidies, Seed Money, and National Security," Sea Power, September 1974, p. 29.

[8]Emery, op. cit., p. 167.

revitalization of the shipbuilding industry such as that accomplished during World War II, nor through the utilization of the lay-up fleet of private and reserve shipping which comprised the bottoms needed for Korea and Vietnam -- these were World War II vintage bottoms and are thoroughly worn out.[9]

Let us briefly trace the events contributing to the decline of U.S. flag shipping over the 1946-1970 period.

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[9]Hall, op. cit., p. 180.

Background: The U.S. flag merchant marine industry is a victim of lack of foresight, inflation, and crisis management:

In many foreign maritime nations, the merchant marine industry is promoted vigorously as a matter of public policy. For over one hundred years, Americans have been apathetic toward the industry except in times of war. Nevertheless, the 1936 Merchant Marine Act, noteworthy in many respects for its recognition of a critical situation, was relatively inflexible with regard to changing trade patterns, technologies, and other factors essential to a dynamic merchant marine. Operating and construction subsidy assistance was extended to the passenger and liner segments of the fleet, but not to bulk vessels or oil tankers. The subsidy program remained unchanged until 1970 when the act was modified to account for burgeoning U.S. petroleum needs. Other liquid and dry bulk cargoes had also assumed a greater proportion of the world's maritime traffic. The end of the Vietnam War signaled a massive retirement, without replacement however, of a majority of this nation's bulk carriers, mainly old freighters and T-2 tankers. A 1954 stop-gap measure, the Cargo Preference Law, required that 50% of all U.S. government-generated cargo, primarily bulk goods and raw materials, should move in U.S. ships. Although many would criticize the Act as a failure in later years, it meant the difference between not operating and bare survival for the U.S. merchant fleet. Most of the older vessels in the fleet would have been scrapped otherwise and thus unavailable for the later traffic needed to support the Vietnam effort.[10]

Another major problem area resulted from the severe post-World War II depression suffered by U.S. shipyards. Many yards either curtailed operations in 1946 or closed altogether. The primary reason was that both foreign and domestic operators had the opportunity to buy U.S. war surplus ships. Most major fleets of the world got their start through the Ship Sales Act passed in 1946. Consequently, American shipowners felt no pressing need to order new ships from the yards, and the yards suffered accordingly.[11]

Simultaneously, with U.S. technical and financial support, Germany, Japan, Norway, Italy and others rebuilt their shipyards offering the latest improvements. The

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[10] Ibid., p. 184.

[11] Ibid., pp. 184, 185.

combination of their momentum and the inertia of a depressed American shipbuilding industry throughout the 1950's and 1960's led to a major technological coup for foreign shipbuilders. They built vessels in series. Techniques of assembly line production and welding reduced costs and launched hulls at a phenomenal rate.[12] American shipyards did not respond to the revolution so rapidly . . . taking an economic beating as a result.

The 1970 Merchant Marine Act, even at this writing, has barely had an opportunity to prove itself. The spectre of costs still pervade U.S. shipyard efforts. Formerly, a construction subsidy rate of 53% meant that a ship costing $23 million in a foreign yard would cost $50 million in an American yard. Any U.S. shipowner competing for traffic without this subsidy immediately recognized the attractiveness of foreign yard construction contracts and registration under runaway flags of the PanHonLib variety. The 1970 Act subsidy arrangements fortunately reflect a narrowing cost differential in domestic vs. foreign shipbuilding -- it is currently 35% for 1975. Some shipbuilding awards (for liquified natural gas) are set for a construction differential subsidy of only 16.5%.[13]

In spite of presently rising foreign costs, however, and dollar devaluations, American ships are still more expensive because the workers that build them enjoy the highest standard of living in the world, as their wages so reflect.[14] What happens when a ship goes into active service?

At hearings before the House of Representatives Subcommittee on Merchant Marine in late 1971, concerning a bill to amend the Cargo Preference Act, it was demonstrated that the most substantial element in the U.S. flag cost differential, once a ship begins operations, is crew expenses -- a function of pay rates and crew size. The operational differential subsidy in effect cannot keep up with wage inflation. The resulting high cost structure affects U.S. flag operations in two types of cargo categories: open-rated cargoes (those available for bid, the majority of which are bulk or non-liner cargoes) and conference-rated cargoes. In the case of the former, U.S. operators are unable to bid competitively because of their higher operating cost structure.

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[12] Ibid.

[13] Ibid.

[14] Ibid.

The resulting loss in volume causes a reduction in their fleet capacity. Thus new ships will not be built because prospective owners cannot secure profitable cargoes. Conference-rated cargoes are a different economic phenomenon. Most of the international conferences in which U.S. flag vessels operate enable them to secure a reasonable share of the market, but because of their comparatively high operating costs, again, the ventures are not particularly profitable. The effects of international/governmental pressures keeping conference rates down and the operations of non-conference carriers ("wildcatters") squeeze the U.S. operator's profits. He is therefore discouraged from assuming the risks associated with building new ships.[15]

Although costs remain a problem that has yet to be solved, one other inhibiting factor is often mentioned by observers of the industry as contributing to the post war decline of the U.S. merchant marine. In a word: divisiveness. Instead of pushing for a revived and competitive merchant marine, U.S. flag shipping leaders divided their limited strength and achieved little. Two prominent examples were the lighter-aboard-ship (LASH) and liquified natural gas (LNG) programs . . . both developed by U.S. operators, but foreign competition capitalized on their commercial use first. Container ships (another U.S. innovation) found their use in the most highly capitalized commercial shipping operations in world maritime history. But it was not until 1970 and the passage of a new Merchant Marine Act that quarrelsome segments of the industry could pursue the common goal of restoring the merchant marine to a competitive stance.[16]

In summary, the post-war anemia of the shipping industry can be ascribed to the following:

1. A nation apathetic toward the merchant marine, except in times of crisis.

2. A lasting shipyard depression brought on by an abundance of surplus bottoms after the war.

3. Shipbuilding and operating costs which are still not competitive with the international market, despite the offsetting subsidies.

4. Dissension and lack of incentive in an industry which could scarcely afford the consequences.

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[15] Ninety-second Congress, Hearings before the Merchant Marine Subcommittee of the House of Representatives Committee on Merchant Marine and Fisheries, Part 1, 5 October-7 December 1971, p. 42.

[16] Hall, op. cit., p. 185.

Discussion: The emphasis centers on getting more deadweight tonnage and the cargo to support it:

The 1970 Merchant Marine Act improved upon the 1936 Act in five important areas[17]: it expands the operating and construction differential subsidies sufficiently to stimulate the ordering of new U.S. ore and energy carriers to be used in the foreign ocean-going trades; U.S. ship operators are allowed to set up non-taxable profit reserve funds for future ship construction; the yearly reduction in the level of construction subsidies is gradually driving U.S. shipyards to more efficient methods of production; negotiated procurement, in lieu of sealed bids, permits a flexible shipbuilding program heretofore not possible; and lastly, under the aegis of MARAD, a National Maritime Council has been formed with representatives of management, labor, and government joined together in a concerted effort to promote public awareness of the need for a strong merchant marine.

Appendix 2[18] displays the U.S. privately-owned fleet of ocean merchant ships (1,000 gross dwt. and over) on a growth basis at five-year intervals commencing with 1963. It is instructive to note the inconsistency in numbers of ships and corresponding tonnage. The 1978 estimated figures of 556 vessels and 20.8 million tons of deadweight tonnage represent respectively 15-year low and high marks for the industry. Commerce Secretary Frederick B. Dent illustrated this phenomenon as an example of "how less can sometimes be more."[19] If in fact the fleet reaches this goal in 1978, we will be significantly closer to the Russians in tonnage than originally projected in Section I of this paper for the year 1980.

The earmarks of success for the 1970 Merchant Marine Act are proudly exhibited by the Department of Commerce. As of 1 March, 1974, MARAD claimed an under-construction and on-order figure of 90 merchant ships with 6.2 million dwt. capacity. Only the crash shipbuilding programs of World War I and II exceed the current effort. Coincidentally, certain non-super power nations stack up as follows in their shipbuilding backlog: Japan - 62 million dwt.; Sweden - 11 million dwt.; Spain and West Germany - 7.6 million dwt. each.[20]

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[17] Ibid.

[18] Editor, "Maritime Administration," Sea Power, June 1974, p. 31.

[19] Ibid.

[20] Ibid.

Government "seed" money in the form of construction differential subsidies, and matching private industry funds of $500 million, have modernized and expanded shipyards to the point where they can make substantial inroads into very large and ultra-large crude oil carriers, and take on in addition the complicated technology of liquified natural gas carriers. The latter construction will be undertaken with only a minimal subsidy necessary. Five of the LNG vessels may be built without any subsidy whatsoever.[21]

Efforts in obtaining more cargo for the U.S. flag fleet have been made manifest by various attempts since 1970 to amend the 1954 Cargo Preference Act. A sampling:

H.R. 10694 - A bill to amend the joint resolution expressing the sense of the Congress with respect to the shipping in United States vessels of products purchased with loans from the United States in order to apply the provisions of such joint resolution to other types of credit assistance.

H.R. 10923 - A bill to amend the Cargo Preference Law.

H.Con.Res. 403 - Expressing the sense of Congress with respect to the application of the cargo preference laws to military cargoes.

H.R. 12324 - A bill to amend the Cargo Preference Act of 1954 for certain purposes.

H.R. 8193 - Energy Transportation Security Act of 1974 (formal title).

The writer was unable to determine which of several measures eventually were signed into law. H.R. 8193, however, received widespread publicity and is a good case to consider because of the surrounding controversy. It provided for 20% of future U.S. petroleum imports to be carried by U.S. flag tankers "at fair and reasonable rates." After 30 June of this year, the percentage would be increased to 25%, and by 30 June, 1977, to 30% providing there is adequate tanker capacity. The benefits to be gained from the bill were cited to be:[22] creation of thousands of new shipbuilding and

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[21] Ibid.

[22] Prina, L.E., "Fair and Reasonable Participation: Big Boost for Merchant Marine," Sea Power, July 1974, p. 29.

ship-manning jobs; maintenance of a U.S. flag tanker capability to move petroleum requirements, especially during crisis periods; development of a cost-monitoring system for petroleum ocean transportation costs, eventually leading to lower petroleum prices for the consumer; reduction of the U.S. balance-of-payments deficit; and protection of the off-shore and high seas environment (presumably by enforcement of stringent pollution standards).

Despite passage by both the House and the Senate, President Ford vetoed the bill earlier this year.

Arguments for "protective" cargo carriage legislation list also the buttress that many of the world's trading and maritime nations enact similar provisions, a fact to which I have previously alluded. Witness Representative John H. Dent from Pennsylvania (1974):

> The Russians just gave us a lesson in international etiquette when they bought -- or, rather, were given the gift of -- our wheat. The whole fight was over whether it was going to be shipped in Russian bottoms. When are we going to learn one simple thing? Trade of any kind is a commercial venture.[23]

Neverthless, the fear has often been expressed that we invite foreign retaliation by enactment of cargo preference laws. Furthermore, because of the inflationary effects of shipping in the higher cost base U.S. flag fleet, the consumer actually pays more for the product, whether it be heating oil or any other common bulk commodity. The Wall Street Journal succinctly underscored a third point recently[24]: because of the federal government's refusal to allow shipments of liquified natural gas in tankers manned by foreign crews, large deposits of fuel located in Alaska would be shipped to Japan, instead of to fuel-short American communities (the Jones Act). No waiver was granted to this law, despite the fact that the United States has no LNG tankers of its own operating at present. In this situation, the U.S. consumer did without altogether.

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[23] Ibid., p. 31.

[24] Landauer, J., "Seafarers Union Uses Its Muscle on Congress, Own Members as Well," The Wall Street Journal, 17 December 1974, p. 1.

Conclusions and Recommendations: Some hard choices to make:

As the president of the Seafarers Union, Paul Hall, recently stated:

> Since 1970, the Merchant Marine Act, the National Maritime Council, and other developments . . . have helped to alter significantly the dismal U.S. maritime outlook. But the battle remains far from won.[25]

The writer believes that certain additional but less publicized steps could be taken to augment the U.S. flag fleet's competitive position in world ocean-going traffic:

1. With respect to increasing cargo through preference legislation, it is recommended that either a tax credit or tax rebate be given to those importers or exporters who voluntarily elect to ship in U.S. bottoms, insofar as these domestic companies pay corporation taxes of any sort. This move may provoke a negative reaction from international maritime conferences and shipowners' associations. It should be advertised as a temporary measure intended solely to aid an ailing industry which will ultimately become competitive in the long run and able to stand the economic rigors of a fierce ocean trade rivalry.

2. We should seek to further bilateral shipping agreements when the opportunity affords. In theory, the federal government has been against departures from free and open shipping competition in the past, other than by tacit consent to avoid losing traffic entirely. We already have agreements with certain South American countries that some 80% of trade -- by specific commodity or all trade in general -- would be handled by either U.S. flag or Latin American vessels. Approximately 20% would be left for third flag vessels. As the Latin Americans have attempted to build up their merchant marine fleets, we have been virtually forced to accept such pools. Why not acknowledge realities and extend the practice?[26]

3. MARAD has been criticized within the last few years or focusing primarily on the design of large bulk carriers (such as the LNG and ULCC) and consequently devoting

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[25] Hall, op. cit., p. 186.

[26] Ninety-second Congress, op. cit., p. 46.

minimal attention to major deep water terminals capable of handling these mammoth vessels. To compete with foreign transhipment facilities in the Bahamas and Canada, it was proposed that the greater capital cost of domestic terminals would be offset by closer proximity to refineries. Hence, lower feeder costs would result.[27] Why not, in addition, offer tax incentives to private capital sources to encourage construction of such terminals, thereby accomodating the U.S. tanker fleet projected for the 1980s?

4. In the short-run, keep operational differential subsidy payments on a liberal basis. In the long run, attempt to narrow the scope of ODS, much as we have already done with construction subsidies. Simultaneously, determine the minimum number of seagoing billets required to man a modernized fleet. Induce all excess employment above a minimum level toward early retirement or severance with appropriate monetary incentives.[28]

5. For many large foreign flag operators, one business is in actuality two businesses: running ships and dealing in hardware -- the trading of ships by purchase or in long-term chartering arrangements. The statement has even been made that very few of the foreign flag operators of dry bulk and tanker vessels would be in the shipping business at all if they could not engage in both businesses simultaneously. Why should not the United States engage in international commerce with our ships as well as cargoes?[29] If we can build technologically superior LNG or LASH vessels let them attract the risk capital from foreign sources into our shipyards. Ignoring construction costs, which are in fact becoming competitive, one might object to this idea because U.S. taxpayers supported the building of these ships through CDS. Yet this is a subsidy to the shipyards and should not carry over to a ship's active service. In any event, when all CDS is removed in a few years the argument will be moot.

6. Waive the Cabatage provisions of the Jones Act until such time as the United States can provide those essential transportation services (such as for Alaskan liquified natural gas going to "lower-48" destinations) which foreign shipping is able to supply. It will not hurt our competitive stance appreciably nor slow the progress of LNG ship construction.

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[27] U.S. Department of Commerce, MARAD 1972 -- A New Wave in American Shipping, 1972, p. 57.

[28] Ninety-second Congress, op. cit., p. 51.

[29] Ibid., p. 52.

7. British and Soviet maritime forces work closely in hand with their respective navies, manning logistic landing ships, underway replenishment ships, tugs, and salvage ships. Privately-owned, civilian manned vessels in this country have demonstrated in isolated experiments that this type of support to the U.S. Navy is well within their capabilities. Thus the Navy would avoid the cost of specialized logistic ships in its forces, calling up instead a diversified merchant marine fleet of LASH, Seabee, RO/RO, and container vessels whenever they were needed. The military Sealift Command might also benefit by not having to lock into "charter and build" vessels proving less useful in the future and tying up excessive capital.[30]

8. Gradually phase out our dependence on the EUSC fleet. The doctrine is tenuous and should not await a major crisis to prove its unreliability. A multinational shipowner's commercial interests lead him to the policy of greatest profits, even in wartime. It is doubtful that the United States could enforce a claim to most EUSC vessels, especially those vessels already plying their regular trade routes during an outbreak of hostilities. With an expanded U.S. flag merchant fleet covering our fair share of ocean-borne trade and serving as a Naval auxiliary, EUSC would rapidly become an anachronism.

Some (or all) of these proposals may seem astonishingly naive in the face of a complex industrial development problem such as the U.S. merchant marine. In the process of sub-optimizing I have neglected many large scale influences which perhaps should have been taken into account. Certain suggestions, on the other hand, may have already been overtaken by events.

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[30]Hall, op. cit., p. 187.

Appendix One

Tonnage Breakdown of U.S. Flag and EUSC Fleets

U.S. Flag Fleet (Private) as of June 30, 1968
(MARAD) Total dwt 15,349,000

	DWT	SHIPS
Tankers	6,937,000	279
Bulk Carriers	999,999	52
Dry Cargo	7,076,000	600
Other	337,000	45
TOTAL	15,349,000	976

EUSC Fleet as of 16 October 1968
Total dwt 15,727,200

Tankers	11,992,400	270
Bulk Carriers	3,316,600	95
Dry Cargo	311,100	30
Other	107,100	17
TOTAL	15,727,200	412

Explanatory note: 1968 figures are given because the writer was unable to obtain EUSC fleet statistics for a later period. The present count of U.S. privately-owned vessels is approximately 600 (see Appendix 2). The figures displayed here are intended to illustrate proportions and the degree to which the United States depends on the EUSC doctrine.

Appendix Two

United States Privately Owned Fleet Oceangoing Merchant Ships 1,000 Gross Tons and Over as of December 31, 1974

	Number of Ships	Deadweight Tonnage
1963		
Freighters	614	6,782,300
Bulk Carriers	63	1,080,300
Tankers	297	6,716,000
TOTAL	974	14,578,600
1968		
Freighters	640	7,418,700
Bulk Carriers	50	977,300
Tankers	277	6,950,200
TOTAL	967	15,346,200
1973		
Freighters	329	4,891,700
Bulk Carriers	26	615,000
Tankers	241	8,209,000
TOTAL	596	13,714,700
1978 (est.)		
Freighters	291	4,683,000
Bulk Carriers	33	1,220,000
Tankers	232	14,936,000
TOTAL	556	20,839,000

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Performance In Mathematics Courses

Factors Influencing Management Student

By

B. C. Sonner, R. E. Smith, & J. D. Finnerty

This study was conducted in an attempt to determine which variables influence success in the three required mathematics courses of the Administrative Science Curriculum. Analyses were performed to relate pertinent explanatory variables to grades in each of the courses. It was felt that benefits would follow if significant relationships could be found.

This paper was prepared as a directed study for LTJG J. D. Finnerty, instructor in the Department of Mathematics at the Naval Postgraduate School.

Introduction:

Students admitted to the eighteen month Administrative Sciences Curriculum (hereafter shortened to 'management program') at the Naval Postgraduate School are automatically enrolled in a series of three mathematics courses during their first two quarters of study: (1) MA 2305, Differential Calculus, (2) MA 2306, Integral Calculus, and (3) MA 2040, Matrix Algebra. These courses are business-oriented and are designed to give students the fundamental mathematics background necessary for study in economics, statistics, and operations research.

Lieutenants B. C. Sonner and R. E. Smith, U.S. Coast Guard, recently received their M.S. degree in Management from the Naval Postgraduate School. Lieutenant Junior Grade J. D. Finnerty received his undergraduate degree from Williams College in 1971 and completed two years of study at Cambridge University in England in 1973. He is presently an instructor in the Department of Mathematics at the Naval Postgraduate School.

Students entering the management program have diverse academic backgrounds. Many students have studied mathematics and related subjects extensively. Others have little or no background in college-level mathematics.

The student who already has the necessary background may attempt to validate the courses through examination, or he may decide to remain enrolled and complete the course. He must take the initiative. There is presently no effective transcript review process to facilitate validation. Instructors offer students the opportunity to validate during the first week of classes, but there is no formal review of transcripts to determine which students are qualified for validation. As a result, only a small percentage of those students who are capable of validating ever do so.

There are several reasons why a student might desire not to validate:

1. Though officers who have been selected for the management program are sent a list of recommended algebra and calculus books suitable for self-study, due to the demands of their present jobs, delays in obtaining study materials, and lack of a study plan or something to force them to study on a regular basis, most students arrive at the School unprepared for a validation examination. As selectees are not made aware of validation procedures and prerequisites, few are motivated to find the time necessary for careful study.
2. There are few alternative courses available to students that early in the curriculum.
3. Most students are reentering an academic environment after several years of military duty. The School's academic environment inculcates a feeling among students that they must attain as high a grade average as possible during their first two quarters. The student usually feels, therefore, that the mathematics courses will provide the needed review, a high grade, and an opportunity to readjust to an academic routine.

This situation has a detrimental effect upon both the students with and the students without adequate backgrounds in mathematics. The student with an adequate background is losing the opportunity to take other courses. Once in the mathematics courses he becomes the driving force in the classroom, setting the pace of study, and determining the

depth at which the material is covered. The student for whom mathematics is new is faced with unfair competition; he is reluctant to slow the class when he does not understand the material; he performs poorly when tested.

Objectives of the Study:

This research was conducted in an attempt to determine which variables influence success in the required mathematics courses. Analyses were performed to relate pertinent explanatory variables to grades in each of the three mathematics courses. It was felt that benefits would follow if significant relationships could be found. Courses could be tailored to students' backgrounds. Criteria for placement could be established. School procedures could be revised to better prepare incoming students and to advise these students concerning possible validation well in advance of their coming on board.

Description of the Variables:

The records of students presently enrolled in the management program were reviewed to obtain the necessary data. The data consisted of information contained in each student's college transcript, each student's Graduate Record Examination mathematics score, and the grades he received in each of the three mathematics courses. Though a larger set of observations would have been preferable from a statistical standpoint, a complete set of data could be compiled for just thirty-seven of the more than one hundred students who have studied in the management program since quarter I, AY 73-74, when the MA 2040-2305-2306 sequence was introduced into the curriculum.

Thirteen pertinent variables were selected initially. Grades from the three courses were the dependent variables. The ten possible explanatory variables were:

1. The number of years (to the nearest quarter) between the student's graduation from college and his matriculation at NPS.
2. The number of course-years[1] (to the nearest quarter) of mathematics courses the student

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[1] A course-year is equivalent to a two-semester or yearlong course.

had taken prior to his arrival at NPS.

3. The number of course-years (to the nearest quarter) of mathematics-related courses the student had taken previously. These courses included advanced economics, physics, engineering and other applied science courses.

4. The number of course-years (to the nearest quarter) of mathematics courses involving calculus and higher mathematics the student had taken previously.

5. A dummy variable taking on the value one if the student had taken calculus previously and the value zero if he had not.

6. The student's college grade point average in mathematics and mathematics-related courses (converted to the NPS 4-point scale).

7. The student's Graduate Record Examination (GRE) mathematics score (the ending zero was dropped for the computer analysis, e.g., 650 became 65).

8. The type of collegiate institution from which the student had graduated: (1) Naval Academy, (2) Coast Guard Academy, (3) public university, (4) private university or (5) Naval Postgraduate School (Baccalaureate Curriculum).

9. The student's overall college grade point average.

10. The number of years (to the nearest quarter) prior to entering NPS since the student had last taken a calculus course.

The SNAP/IEDA statistical computing package was used in performing the analyses. One limitation of this package is that it allows for only ten variables. Since the information required to rate the quality of undergraduate education each student had received was not available, variable 8 was dropped. Variable 9 was excluded since variable 6 would provide a more relevant measure of the student's undergraduate performance. Since none of the students in the sample had taken a calculus course between their graduation from college and their arrival at the School, with variable 1 in the model variable 10 became redundant. So variable 10 was dropped, leaving the first seven independent variables listed above as variables 1 through 7 in the three performance models. Variables 8, 9 and 10 in the analyses were then the MA 2305, MA 2306, and MA 2040 grades, respectively. Hereafter the variables will be referred to as X_n, where the subscript identifies the variable according to the ordering described above.

The Models:

Three performance models were formulated, one for each of the three mathematics courses.

Model 1: MA 2305

$$X_8 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7$$

Model 2: MA 2306

$$X_9 = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7$$

Model 3: MA 2040

$$X_{10} = \gamma_0 + \gamma_1 X_1 + \gamma_2 X_2 + \gamma_3 X_3 + \gamma_4 X_4 + \gamma_5 X_5 + \gamma_6 X_6 + \gamma_7 X_7$$

It was expected that each of the variables X_2 through X_7 would be positively correlated with the dependent variable in each model. A larger number of mathematics and mathematics-related courses taken, greater success in these courses as indicated by the student's grade average, and a higher aptitude for mathematics as indicated by the student's GRE score in mathematics, would each be expected to produce a better performance (i.e., a higher grade) in each of the three courses. The coefficient of variable X_1, measuring time elapsed between the student's graduation from college and his matriculation at NPS, was expected to be negative. The greater the elapsed time the more difficult it is to recall concepts previously learned and the more difficult it is to readjust to an academic environment.

It was recognized that some of the explanatory variables would be correlated with one another. Those variables indicating the number of course-years of mathematics courses taken, X_2, the number of course-years of mathematics-related courses taken, X_3, and the number of course-years of courses taken involving calculus and higher mathematics, X_4, were expected to be positively correlated. In addition, the dummy variable X_5 would become redundant if either X_2 or X_4 were included in the model. It was decided to let the stepwise regression package sort out the relevant explanatory variables, and it was anticipated that this would result in at least three of the explanatory variables being dropped from each model.

It should be noted that the three models omit a very important factor influencing student performance: the attitude of the student towards the management program in general and towards the mathematics courses in particular. This omission was unavoidable since data were not available. It is, however, an important factor which undoubtedly affected the final results. In some cases a student who had a rather weak background in mathematics and who had achieved average grades in college was able to earn an "A" in each of the three courses. This was due in large part to nonquantifiable factors such as the student's determination to do well because his performance at NPS would affect his career. Leaving these factors out of the models would tend to diminish their explanatory power.

It should also be noted that only one student in the sample had ever had a course in matrix algebra. Thus a student's previous work in mathematics would be expected to have a smaller effect on his MA 2040 grade than on the grades he received in the other two courses. Time elapsed since graduation and mathematics aptitude would be expected to be relatively more important in model 3 than in either model 1 or model 2.

Data Collection: Procedures Used and Difficulties Encountered:

Data collection involved numerous difficulties. Transcripts differed widely as to (1) course title and designation, (2) course description, (3) length of academic term, and (4) grading scale. Course content also varied. Some interpretation was required to translate the information to a common base for analysis.

Establishing values for variables X_2, X_3, X_4 and X_5 required some assumptions concerning course content. Since time constraints precluded a careful evaluation of each college's mathematics courses, a rough comparison was made on the basis of course titles. It was assumed that two semesters were equivalent to three quarters, which were in turn equivalent to one academic year. It was felt that the above assumptions would have only a very small effect on the study's findings.

A second major difficulty encountered was the lack of complete information on all students. For some students there was no GRE score. Some had not received grades for MA 2306 as of the time of the study. Transcripts were unavailable for other students. Students for whom complete information was not available were excluded from the analyses. This meant

that all Coast Guard students were excluded from the analyses since they lacked GRE scores. While seventy-eight sets of records were reviewed initially, complete data were available for just thirty-seven students. As long as the thirty-seven students in the sample were representative of the entire group, these data limitations would not seriously affect the overall results. However, the exclusion of a large group of students, for example the Coast Guard students, could have biased the results. It was felt that the amount of bias, if any, was small.

Data Analysis:

The statistical properties of the ten variables used in the models are listed in the table on page 10. These properties provide an informative abstract of the background and characteristics of the thirty-seven management students in the sample. When he entered the program the average management student had been out of college 8¼ years, though some students had been out as little as 2½ years. Some had been out of college as much as 15 years prior to entering NPS.

The students' mathematics backgrounds also varied. The average student had taken 2 1/3 course-years of mathematics courses as an undergraduate. As many as five course-years of mathematics and as little as one-half course-year of mathematics were found. The average student had taken 4½ course-years of mathematics-related courses, but the range extended from zero to 14½ course-years.

Over eighty per cent of the students has taken calculus previously, but undergraduate mathematics grades were about average (clustered in the C+, B- range). Graduate record mathematics examination scores averaged between 620 and 630 and ranged from 450 to 770.

Grades in the NPS mathematics courses were high and clustered. The average grade was in the B+ to A- range for all three courses and the three standard deviations were small. This lack of variation made it difficult to separate out the effects of the different factors influencing student performance in the three mathematics courses.

Regression Results:

The associations between the variables were examined through correlation analysis. As anticipated X_2, X_3 and X_4 were found to be highly correlated with one another. More-

TABLE
STATISTICAL PROPERTIES
OF THE TEN VARIABLES
37 OBSERVATIONS

VARIABLE 1
(Years Since Graduation):

MEAN	8.216
STANDARD DEVIATION	3.605
MEDIAN	7.500
MINIMUM VALUE	2.500
MAXIMUM VALUE	15.000
RANGE	12.500

VARIABLE 2
(Course-Years of Math Crs):

MEAN	2.343
STANDARD DEVIATION	0.997
MEDIAN	2.300
MINIMUM VALUE	5.000
MAXIMUM VALUE	5.000
RANGE	4.500

VARIABLE 3
(Crs-Yrs of Math-Rltd Crs):

MEAN	4.457
STANDARD DEVIATION	3.782
MEDIAN	4.000
MINIMUM VALUE	0.000
MAXIMUM VALUE	14.500
RANGE	14.500

VARIABLE 4
(Crs-Yrs of Cal & High Math Crs):

MEAN	1.584
STANDARD DEVIATION	1.096
MEDIAN	1.500
MINIMUM VALUE	0.000
MAXIMUM VALUE	5.000
RANGE	5.000

VARIABLE 5
(Calculus-Yes(1), No(0)):

MEAN	0.838
STANDARD DEVIATION	0.374
MEDIAN	1.000
MINIMUM VALUE	0.000
MAXIMUM VALUE	1.000
RANGE	1.000

VARIABLE 6
(College Math & Math-Rltd GPA):

MEAN	2.533
STANDARD DEVIATION	0.733
MEDIAN	2.410
MINIMUM VALUE	1.210
MAXIMUM VALUE	4.000
RANGE	2.790

VARIABLE 7
(GRE Math Score):

MEAN	62.514
STANDARD DEVIATION	7.629
MEDIAN	63.000
MINIMUM VALUE	45.000
MAXIMUM VALUE	77.000
RANGE	32.000

VARIABLE 8
(MA 2305 Grades):

MEAN	3.451
STANDARD DEVIATION	0.664
MEDIAN	3.700
MINIMUM VALUE	1.700
MAXIMUM VALUE	4.000
RANGE	2.3000

VARIABLE 9
(MA 2306 Grades):

MEAN	3.549
STANDARD DEVIATION	0.532
MEDIAN	3.700
MINIMUM VALUE	2.300
MAXIMUM VALUE	4.000
RANGE	1.700

VARIABLE 10
(MA 2040 Grades):

MEAN	3.492
STANDARD DEVIATION	0.638
MEDIAN	3.700
MINIMUM VALUE	1.700
MAXIMUM VALUE	4.000
RANGE	2.300

over, they were found to be highly correlated with X_5. As X_5 had a higher partial correlation coefficient with each of the dependent variables than did X_2, X_3 or X_4, it was decided to adjust for multicollinearity by excluding X_2, X_3 and X_4 from the regression. After this adjustment no significant multicollinearity remained in any of the models.

Also as expected, all the variables except X_1 were positively correlated with each of the dependent variables. Of the four explanatory variables employed, X_5 was the most highly correlated with X_8, while X_7 was the most highly correlated with X_9, and X_1 was the most highly correlated with X_{10}. Of the three dependent variables X_{10} showed the least correlation with the explanatory variables.

Stepwise regression was performed employing variables X_1, X_5, X_6 and X_7 as explanatory variables in each of the models. Several different forms for each model, including logarithmic and semilogarithmic forms, were tested. It was found that the linear model yeilded the best results in each case.

A decision rule was chosen that set the significance level at .05. For each of the three models one-sided tests of significance were carried out on the regression coefficients. An observed t statistic was computed and compared against the .05 critical value. To test the significance of each model an observed F value was computed for each model and compared against $F_{.05}$.

First, variable X_8 was regressed on variables X_1, X_5, X_6 and X_7. Stepwise regression indicated that only X_1 and X_5 should be included in the model, resulting in the following form for model 1:

Model 1

Student Performance in MA 2305

$R^{-2} = .401$

$F_{obs} = 13.05$

$$X_8 = 3.332 - .076X_1 + .884X_5$$
$$[3.166] \quad [3.745]$$

The observed t value (with 34 degrees of freedom) for each regression coefficient appears in brackets beneath the coefficient. Each regression coefficient is highly significant at the .05 level and remains significant even at the .005 level. The observed F value is highly significant at

the .01 level. The adjusted coefficient of multiple correlation $\bar{R}^2$ for this regression equation indicates that variation in variables X_1 and X_5 explains 40.1 percent of the variation in variable X_8. According to the model a student's MA 2305 grade will be on average .076 grade points lower for each additional year since the student's graduation from college. It further indicates that there is almost a full grade point (.884) difference between the grades earned by students who have had calculus previously and the grades earned by those who have not.

Model 1 suggests some guidelines for deciding which students should be encouraged to take the MA 2305 validation exam. According to the model a student who had previously taken a course in calculus and who had entered NPS within seven years of his graduation from college would be expected to earn a grade not lower than "A-" in MA 2305. The more recent the officer's graduation from college, the higher would be his expected MA 2305 grade. Especially in view of the effect of previous calculus study - or lack of it - on the performance of students in MA 2305, recent college graduates whose transcripts list one or more courses in calculus should be urged to take the MA 2305 validation exam. The only exception would be a student who had received very low grades in calculus. A transcript analysis worksheet for computing an incoming student's expected MA 2305 grade is contained in the appendix.

Second, variable X_9 was regressed on variables X_1, X_5, X_6 and X_7. Stepwise regression led to the following form for model 2:

Model 2

Student Performance in MA 2306

$\bar{R}^2 = .540$

$F_{obs} = 22.13$

$$X_9 = .698 + \underset{[3.278]}{.554X_5} + \underset{[4.750]}{.038X_7}$$

The observed t value (with 34 degrees of freedom) for each regression coefficient appears in brackets beneath the coefficient. Each regression coefficient is highly significant at the .05 level and remains significant even at the .005 level. The observed F value is highly significant at the .01 level. The adjusted coefficient of multiple correlation $\bar{R}^2$ equals .540, indicating that variation in variables X_5 and X_7 explains 54.0 percent of the variation in variable X_9.

As in MA 2305 whether or not the student has had calculus previously is an important factor in determining how well he will do in MA 2306, contributing on average .554 points to his grade. A one hundred point difference in the student's GRE score would mean on average a .38 grade point difference (roughly the difference between a B+ and an A-). It appears that for MA 2306 mathematics aptitude as measured by the GRE in mathematics is the most important factor influencing student performance in that course. GRE scores alone explained 39.4 percent of the variation in MA 2306 grades.

Model 2 suggests some guidelines for deciding which students should be encouraged to take the MA 2306 validation exam. A student who has previously studied integral calculus and who has achieved a score of 72 or higher on the GRE mathematics examination should be encouraged to take the MA 2306 validation exam. At the present time students entering NPS are not required to take the GRE in mathematics. It is recommended that incoming students be required to take the GRE, and that these scores be used for placement purposes. A transcript analysis worksheet similar to the one suggested for MA 2305 and based on model 2 is contained in the appendix.

Finally, variable X_{10} was regressed on variables X_1, X_5, X_6 and X_7. Stepwise regression produced the following form for model 3:

Model 3

Student Performance in MA 2040

$\bar{R}^2 = .221$

$F_{obs} = 6.11$

$$X_{10} = 2.578 - \underset{[2.259]}{.061X_1} + \underset{[1.769]}{.023X_7}$$

The observed t value (with 34 degrees of freedom) for each regression coefficient appears in brackets beneath the coefficient. Each regression coefficient is significant at the .05 level. The observed F value is barely significant at the .01 level. The adjusted coefficient of multiple correlation $\bar{R}^2$ equals .221, indicating that variation in the variables X_1 and X_7 explains 22.1 percent of the variation in variable X_{10}. Thus the explanatory power of model 3 is weaker than the explanatory power of models 1 and 2.

Unlike models 1 and 2, whether the student had previously taken a course in calculus was not an important factor in model 3. Since only one student in the sample had previously

taken a course in matrix algebra and since calculus and matrix algebra require different skills, this result is not surprising. As would be expected, time away from school, X_1, and general mathematics aptitude, X_7, provide a better indication of how well a student will do in MA 2040. In MA 2040 students were able to compete on a more equal basis, with mathematics aptitude and time elapsed since graduation from college affecting student performance to a greater extent in MA 2040 than in either MA 2305 or MA 2306.

Since only one student in the sample had previously taken a matrix algebra course there does not appear to be a need for a matrix algebra validation model at the present time. Moreover, as neither of the variables in model 3 directly represents previous training in mathematics, model 3 would not be useful in deriving a set of validation guidelines for MA 2040 should the need arise in the future. Within the last few years many colleges have begun to offer courses in matrix algebra designed for students not majoring in mathematics. Should the number of students entering the management program with previous training in matrix algebra increase in the future, then the procedures discussed in this study should be used to reformulate model 3 and to develop validation guidelines for MA 2040.

Overview of the Results:

Of the factors considered in this study the three which were most important in affecting a student's performance in the three required mathematics course were: (1) the number of years since the student's graduation from college, (2) whether or not he had taken a calculus course previously, and (3) the student's mathematics aptitude as measured by his Graduate Record Examination score.

While models 1 and 2 are helpful in predicting how well a student will do in MA 2305 and MA 2306 and in deriving guidelines for validation purposes, there are factors other than those which could be considered here that contribute to the grades a student receives. Different instructors use different grading criteria. The use of quantitative skills in duty assignments varies greatly. Motivational factors also exert an influence. None of these factors could be incorporated in the models due to lack of data. While the omission of these and other factors undoubtedly affected the statistical results, it was felt that this effect was small enough so as not to affect materially the study's conclusions.

The omitted factors together with the clustering in the grade distributions, which was discussed in the Data Analysis Section, are at least partially responsible for the relatively low R^2 values for the three models. The variation in R^2 values from .221 for model 3 to .540 for model 2 reflects the importance of prior course work in mathematics in determining how successful management students will be in their mathematics courses. In both MA 2305 and MA 2306 those students who had previously studied calculus held a tremendous advantage over their classmates who had not. This factor accounted for a large portion of the variation in final grades, and both model 1 and model 2 had R^2 values significantly higher than the R^2 value for model 3, in which previous training in mathematics was not a significant factor.

Conclusions and Recommendations:

The regression results suggest the need for a change in the method of assigning management students to mathematics courses, as well as other changes which would enable and indeed, encourage, the student to make better use of his time on board:

1. Those students capable of validating one or more mathematics courses should be identified prior to their arrival at NPS. Criteria should include: (1) whether the student has had calculus previously, (2) the number of years since the student's graduation from college, and (3) the student's Graduate Record Examination mathematics score.
2. Every prospective management student should be required to take the Graduate Record Examination in mathematics.
3. Course objectives should be sent to incoming students along with recommended study materials. The incoming student should be informed as to the possibility of validating mathematics courses, and he should be given guidelines so that he can determine whether he could qualify for validation after a reasonable amount of individual study.
4. Students in MA 2305 and MA 2306 should be segregated according to whether or not they have taken calculus previously.
5. More individual attention should be paid to each student and to his academic background. Each student should be advised and placed in courses commensurate with his background and ability.

6. A more individualized and more flexible instructional approach, like the PSI method of instruction, might prove highly beneficial due to the variety of backgrounds and abilities of management students.

7. More background information should be obtained on each student. The content of mathematics courses previously taken, job history, and personal objectives should be made known to each student's academic advisor. A sample worksheet to aid the advisor in transcript analysis is presented in the appendix.

8. Greater effort should be devoted to making students aware of the opportunity to validate, to encouraging the student to validate, and to developing alternate courses so that he will be motivated to validate.

9. Since mathematics courses are preparatory courses for later work, a pass/fail grading system should be considered. Changing to a pass/fail system would ease competitive pressures in the classroom and would encourage more able students to validate.

10. Further study of the factors relevant to academic success, and in particular those factors affecting student performance in MA 2040, MA 2305 and MA 2306, is strongly recommended. This would lead to further improvements in both curriculum and course design.

APPENDIX

TRANSCRIPT ANALYSIS WORKSHEET

MA 2305

(Calculus: yes = 1, no = 0 _____ X .884 = _____

(Years since graduation) _____ X(-.076)= _____

3.332

Expected MA 2305 grade _____

Predicted grade of 3.7 or higher (previous calculus course plus not more than seven years since graduation) indicates that the student should be encouraged to take the MA 2305 validation exam.

MA 2306

(Integral Calculus: yes = 1, no = 0) _____ X .554= _____

(GRE score in mathematics*) _____ X .038= _____

.698

Expected MA 2306 grade _____

*Raw score divided by ten.

Predicted grade of 3.7 or higher (previous integral calculus course plus a GRE score of 72 or higher) indicates that the student should be encouraged to take the MA 2306 validation exam.

All Volunteer Force Management

By James M. Gilbert

The author discusses the historical background leading to the present all Volunteer Force, some of the problems that have surfaced during the first few years, their effect on managers and leaders in the military, and the effect of the economy on the number and caliber of enlistees.

This paper was submitted to Professor Church for Personnel Management and Labor Relations (MN 3101).

Introduction:

The All Volunteer Force is being hailed by many as a complete sucess. Assistant Secretary of Defense (Manpower and Reserve Affairs) William K. Brehm told the press on 14 November 1973 that the Services were only 2 percent below planned strength at the end of September (6-12). Rear Admiral John R. Fisher, CEC, Commander, Construction Battalions, Pacific, in addressing a group of Civil Engineer Corps officers and wives at a luncheon at the Naval Postgraduate School in January 1975, made reference to the fact that the Seabees were getting the best group of enlistees that they had experienced in a long time. Dr. Harry J. Gilman, in addressing the MN 3101 class on 3 March 1975, spoke of being a member of the 1969 President's Commission on an All-Volunteer Armed Force and how proud he was that the resulting recommendations provided for the successful All Volunteer Force that we have today. All of these persons appear to be fully satisfied that the program is a success and it may well be. Numbers can not be disputed and an optimist would say this meets the criteria for success.

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For the pessimist, success can't be measured solely by numbers. There are some instances where, similar to a golfer's score, large numbers are indicative of present and future problems, not success.

This paper will briefly review the historical background leading to the present All Volunteer Force, some of the problems that have surfaced during the first few years, their effects on managers and leaders in the military, and the effect of the economy on the number and caliber of enlistees. It will let you, the reader, decide whether a judgement on the success or failure of the system may be premature at this time.

History:

The All Volunteer Force concept was brought about by many separate, yet vaguely associated, events. For years the public has been less than enchanted with the conscription of its youth. The draft had been in effect since 1940 and the peopled affected the most had really never experienced the absolute freedom of choosing their career without the ominous threat of being selected to serve in the armed forces at a period of time that may or may not coincide with their plans for education or job training. It seemed that everything depended upon the drawing of a number and its correlation with a birthdate. The threat was not in serving, it was only in the selection of the time. Different manners of selection were tried, different methods of choosing those who would serve and those who could be granted deferments, all with negative results as far as quieting the clamor to end the draft. Each time this clamor reached major proportions, a military or political situation would surface that required military support. The Berlin Airlift, the Korean conflict, the Cuban Missile Crisis, and finally the Vietnam War all played an important role in justifying the continuance of the draft. Strangely enough, the one that placed the largest demands on the Selective Service system in recent years, Vietnam, also hastened the demise of it. In 1969 the majority of the populace of the United States was greatly disenchanted with the war in Southeast Asia which had been dragging on for over 8 years. Legislators were voicing misgivings about our involvement. The cost of lives and money was becoming more than the American people were willing to bear. The following statement fairly well sums up the public opinion during this period of time:

> The dismay of the public was reinforced by the embarrassing capture by North Korea of the Pueblo spy ship in 1968, the shooting down of a Navy

> plane in 1969, and the disclosure of military scandals, such as deals by Army sergeants major in noncommissioned officers clubs, the alleged murder of a Vietnamese double agent by Green Beret special forces, and the apparent war atrocities committed at the Vietnamese hamlet of Song My and elsewhere (7-435).

President Nixon, in an effort to quiet the unrest in the country, decided that greater emphasis had to be placed on withdrawal from Vietnam. Reduction in the number of personnel in the Defense establishment and the ending of the draft were subsequently needed.

A panel composed of 15 prominent members of society, among them 2 retired Generals, a Priest, an ex-Secretary of Defense, and the rest giants in their own field, was appointed by the President in 1969 to study the feasibility of and make recommendations concerning the establishment of an All-Volunteer Armed Force. The more important areas, such as military personnel requirements; supply of personnel to the military; historical, political, and Social Research; as well as other studies, were investigated and firm recommendations made. The military would have to provide its personnel with equitable pay, comparable living conditions, and proper equipment to perform their mission in order to compete with the private sector for acceptable personnel. Last but not least, its members must be presented with real job-satisfaction.

Problems:

1. To quote General Hackett, British Royal Army,

> What a society gets in its armed services is exactly what it asks for, no more, no less. What it asks for tends to be a reflection of what it is. When a country looks at its fighting forces it is looking in a mirror. If the mirror is true the face it sees there will be its own (2-44).

The point here being that a regular military force composed of all volunteers can not be procured cheaply. If a highly trainable force is to be maintained, one that is truly suitable for the task required, then the cost must be borne. If the cost is slighted or cut drastically, the end result will be a nucleus force composed of all volunteers but ill prepared to carry out its mission. One of the more important missions, often overlooked, is the awesome task of refreshing

or retraining reserve components that may be activated in a crisis. In the event of a major crisis, a large influx of raw recruits could be inserted as the result of a reinstituted draft. It should be explained that there are few scenarios for future wars that provide for the entire action to be borne by the regular force. In practically every situation a mobilization of reserves and/or reinstitution of the draft is contemplated. High quality, professional military personnel must be available to guide the efforts of these additional people. Thus, finances can easily become a problem. This becomes more paramount as the smell of gun-smoke and the sounds of explosions become weaker.

Solution: If the All Volunteer Force is truly a success and is to remain a success each and every taxpayer must be fully aware of the high cost to maintain such a force. We cannot let misinformation or the soothing tones of detente lull us to sleep. At the same time, if the necessary funds are provided, each and every military person must insure that each dollar is utilized to the highest degree of efficiency. By proving to the taxpayer that he is represented by excellent managers, money may not become the force that pushes the United States from the power pedestal.

2. The false security that may be inherent in relying on numbers alone. In an article in the December 1973 issue of The Armed Forces Journal, Secretary of the Army, Howard Calloway, presented some glowing facts about the success of the All Volunteer Force program. He said that in the past few months the Army had recruited some 124,000 young men and women and during this period had seen some 34,000 re-enlistments. He further pointed out that, since the end of the draft in December 1972, the Army had been able to maintain an 84 percent level of its recruiting goals. To quote Secretary Calloway,

> We have had a higher percentage of high school graduates entering the Army since the draft ended - about 10 percent higher - then we had in the six months before the end of the draft. As a result, we now have an Active Army of over 794,000 and this is 97 percent of our programmed strength. Total accessions, then, have fallen somewhat short of our goals, but we are still filled far above any level of concern and quality is high (6-12).

In December 1973 this apparently looked very encouraging. However, a story carried in the San Francisco Chronicle on 2 December 1974 did not reflect this confidence. The Army, in this article, claimed that the All Volunteer Force was drawing people to the Army that were not brought by "generally love of the country, but the bleak employment picture on the civilian job market and the promise of learning job-related skills." In this article the Army quotes figures concerning new enlistees and their mental test results. The military uses categories from one to five, with one being the quickest witted and five being the slowest, to classify the ability and aptitude of their personnel. The figures show a marked decline in the Category Ones that are enlisting and an even greater decline in the Category Two group.

Category	Year 1972	Year 1974
I	6.5%	2.5%
II	36.0%	23.8%
III	42.1%	56.5%
IV	15.0%	15.0%

It should be pointed out that the services are no longer accepting Category Five personnel. While the above figures reflect that the percentage of Category Ones could be approaching a critical level, there seems to be little or no concern as we are able to recruit the desired total strength. The statistician might say this is proof that the system is working. The military manager or long range planner may be a little concerned lest the scales become tilted toward low quality personnel.

Solution: Be constantly aware of all outside influences that may cause input variables to change. The British, who have a lot of experience in a Volunteer Military Force, have recognized the effects of the national economy on the inputs to the armed services. They say, "There is undoubtably a correlation between unemployment and enlistment in the fighting services (2-45)." This could definitely be a factor in the present upsurge in recruiting. If this upsurge cannot be explained this way, it surely is a direct reflection on the private sector in that Category Twos and Threes are not being provided equal employment with the Category Ones.

3. Is there a danger that we may end up with a service of minorities? In the December 1973 article concerning Secretary Calloway's statements on the success of the All Volunteer Force the following figures are found. The Marines were successful in recruiting 69 percent of their quota, the Navy surpassed their quota by reaching 101 percent of their goal, and the Air Force topped this by achieving 107 percent of their goal. By adding Army figures of 84 percent, this averages out to approximately 90 percent of the combined target figures. Does this indicate that all is rosy? Far from it, as pointed out in the June 1974 issue of the Armed Forces Journal where figures show that Blacks represented 20 percent of the total Army strength (up from 14 percent in 1970) and 18 percent of the Marine Corps (up from 11 percent in 1970). This compares with a 12.4 percent of Blacks in the 17-20 age group in the general population. It should be remembered that these figures are for Blacks only and do not include other minority groups that are represented in the military. In June 1973 the Navy had a definite quota for the number of Blacks and other minorities to be recruited. These were set at 12 percent for Blacks and 6 percent for other minorities (3-126). If these figures can be used as a guide, we could be looking at an Army composed of 30 percent minorities and a Marine Corps that includes 27 percent minority members. Personal experience indicates that this figure is not unrealistic. Such a fear was expressed in the report of the President's Commission. This could be an indication that society is not providing ample opportunity for the employment of minorities. One must ask, if they are not suitable for the private sector, should the military be tasked with providing the necessary training and experience to better prepare them for societies needs? Whatever the cause of the problem, the situation could impose a much deeper problem if the armed services were called upon to fight a limited engagement.

Solution: Adopt a set of standards that apply to both the military and the civilian sector. If a person cannot compete in the private sector, he should not be expected to compete in the military sector. If there is to be any difference, tilt the scales toward the military. However, there is really no need for the military to be so different than the society from which its members come. Brigadier General J. McKinley Gibson USA (Ret) said it rather nicely:

> Certainly the military must set high standards. It must conduct tough, realistic training. It must preach the importance of honesty and integrity, patriotism and loyalty. Officers and men

> must be physically hard, resolute, self-confident and thoroughly knowledgeable of the military craft. The motto 'Duty, Honor, Country,' says it all. But having said it, does anyone really believe the American Armed Forces can make its men much different than the society from which they come? Offering them a code to live by, can it expect them to have a totally different outlook; a different set of values? Would it want to, even if it could? (4-18)

Thus, to task military leaders and managers with the burden of training, educating, and reorientation of both the majority and minority races could detract from their main mission. Once again, to briefly quote General Gibson;

> Certainly, no other group of people in this society has a greater stake in fully understanding the current motivations of the American people than do the military. Preparing for the day when young American draftees must once again be trained and motivated to fight should be uppermost in the minds of professional soldiers. Is it? (4-18)

Are we guilty of detracting from the quality of the Armed Forces when we lower standards to accept certain groups?

4. Without the draft, can a sufficient number of professional people be recruited for the Armed Forces? This is one of the problems that has been uppermost in the minds of both military and civilian personnel planners. The medical profession has created the most concern. There can be no substitute in this field. A ship at sea or a unit in the field must have ready access to a doctor and there are no alternatives. The draft provided the Armed Forces with a ready supply of these professionals but this is no longer the case. Now that the All Volunteer Force is a reality there are several different approaches to the problem.

Solution: There appears to be no one dominant solution to this problem. The different approaches all have merit but it will take considerable time to see if they will work in the long run. The Navy is constructing a medical facility to train people for a career in the Medical profession. This facility will not be completed for several years and then it will be quite a few years after that before the first group graduates and is ready to assume full time

service as medical doctors. This is an expensive operation and the cost will continue to rise. As the peace-time years continue to increase and the memory of war-time needs disappear it will be interesting to see if the public will fully support such an operation. The Air Force has an extensive recruitment program in operation to procure the necessary medical personnel. It is known as the "Fully Qualified Physician Recruitment Program" and is designed to fill some 600 vacancies. An example of how it works was illustrated in an article released by the United Press and carried in The San Francisco Chronicle on 3 March 1975. A 48 year old general practitioner, who had served as an Army rifleman during World War II and as an intern doctor during the Korean conflict, was signed to a four year contract with a special annual salary of $44,700. His rank is that of a colonel. Granted that this is only one case and there may not be many recruited at such a high rank, it still illustrates the cost that must be borne in order to obtain personnel experienced in such a highly professional field. In the article it appeared that the pressure of long hours and the high cost of living in the private sector played a significant role in making up this doctor's mind. In explaining why he was accepting a position that brings in approximately 45 percent of his present gross salary the doctor said, "I'm going to lose some, but I'll be making more per hour. My work week has been running 60 to 80 hours." Taxes and overhead expenses were consuming about 50 percent of his civilian income. His wife remarked, "I think its fine, we may all have a chance to eat together." Does this speak well for the society from which he comes? An even greater problem that such lateral recruitment and placement is apt to bring is the discontent that such high financial renumerations may cause among the flag rank personnel and the top grade civilians in the public service. These dedicated servants, regardless of whether they are in the Administrative service, educational service, or the Armed Forces are all limited to a top salary of $36,000 per year. They too, are highly skilled and perhaps have more experience in their field than the doctor that was recruited at a higher salary. Will such inequities cause problems in the very near future?

5. Will an upswing in the economy affect the present success of the All Volunteer Force? This is the type of question that there are many answers to. History of the volunteer service in this country would tend to make a person believe that the success or failure of recruiting is directly tied into the economy. Recruiting was excellent during the depression years of the 30's. There were waiting

lists for practically all armed services and the selection was based on quality and not quantity. The Armed Forces were rather small in those days as the U.S. had not achieved the status of a superpower. However, we had achieved such a status in 1973 and recruiting was not meeting its goals. There appears to be a definite correlation between Armed Force recruiting and the economy. Other factors beside financial income affect recruiting. Great interest is being generated in the medical ranks, for service in the military, because of the liberal awards of the high courts in malpractice suits. Such variables as these cannot be discounted nor should they be relied upon to provide people.

Solution: There is no apparent solution to this problem. It is, and will continue to be, an unpredictable factor that must be recognized and dealt with as it arises. The overall plan to provide suitable numbers of personnel to the Armed Forces will have to be viable enough to compensate for such variables.

Such problems could be listed for several more pages. However, the list seems to be long enough to give credence to the doubts of those who say it may be too soon to acclaim the All Volunteer Force a complete success. The apparent success of it has placed many additional burdens on the career personnel of the Armed Forces. They must relearn some of the basic skills of their trade to cope with the new-society oriented people that make up the majority of the new enlistees. It will require greater managerial expertise and a different type of leadership than that which the military is accustomed too. An article in The San Francisco Chronicle of 2 December 1974 quoted a ten year Army veteran as saying, "I miss the discipline, you shout at these guys for two hours, they cry for an hour, and then, maybe, they do what you tell them. It ain't like the old Army." On the same day in The Barometer, the Naval Postgraduate School paper, this saying was printed, "In the modern military, the best leaders are born and made -- by education, experience, and hard work -- and they have to move with the times." Managers and leaders in the military, as well as those in the civilian community, have to move with the times. Once this attitude is completely accepted in the military and such acceptance is reflected throughout the adjoining civilian community; then, and only then, if recruiting goals are still being met, the supporters can claim that the All Volunteer Force is an unqualified success. There is no reason why is should not work. After all, we were able to support an Army, of sorts, for all by 33 years without conscription. But let us not forget that times, like leaders, change. During the majority of the years that volunteers staffed our forces, we were not the superpower that we are now.

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Graduate Education For Military Officers

By C.R. Schramm

Recently, graduate education for Military Officers has come under heavy scrutinizing from Congress as well as the General Accounting Office. This article discusses the validity of these attacks and examines the cost of alternative methods of supplying individuals with graduate schooling to meet military requirements.

This paper was presented to Professor Fenn C. Horton for Managerial Economics, (MN 3143).

Introduction:

In the past, the general if slightly exaggerated rule with regard to training in the military seems to have been "more is always better than less." Individuals in the military have spent large amounts of time in formal training programs, often running as high as 30 to 40 percent of the career of some individuals. Once a specific training program is in operation, it has seldom been discontinued. Quite the contrary, it has usually been expanded or upgraded. New training programs spring up and individuals have been processed through them with very little consideration of the costs.

Such practices, however, are ending. Perhaps as a response to the times - the result of the twin evils of inflation and recession - perhaps as a symptom of the growing distaste of any aspect of militarism, or perhaps for a reason not yet clearly defined, the Congress and other agencies are taking a hard look at military training, and in many cases

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drastically reducing the amount of funds available to carry out existing programs. The merits of such general cutbacks, if any, are, by and large, beyond the scope of this paper. The focus of attention here is one specific and very costly are of military training that has come under particularly heavy attacks of late: graduate education for military officers. In 1975 over 6800 officers will be paid full salaries along with tuition and other expenses while attending graduate school. In return they will contract to remain in the military for a period of time equal to two times the length of schooling, though this varies across the services. This graduate schooling program, budgeted at over $100 million, has been directly attacked by the General Accounting Office, "Improvements Needed in Determining Graduate Education Requirements for Military Officer Positions," B-165558, August 28, 1970, by Congress, and is an object of study by each of the individual services.

This paper discusses the validity of these attacks and examines the cost of alternative methods of supplying individuals with graduate schooling to meet military requirements. Examined are different possible decision rules for deciding who should be sent to school in terms of probabilities of recouping the costs, and second, the cost advantages of replacing some or all the programs with civilian hirings is examined.

Methodology:

The basic decision rule for the investment in training by a given firm is simply that the discounted sum of returns from a training investment must equal or exceed the discounted sum of the costs (Becker, 1964). For any firm, the returns for the investment come from the trainee's marginal product being greater than the wages he is paid; the costs include all direct payments, such as tuition, plus wages during the training. The decision rule for one year of training is as follows: (A complete development of this rule is found in Gary S. Becker's book Human Capital).

$$W_o + C = MP_o + \sum_{t=1}^{M-1} \frac{(MP_t - W_t)}{(1 + r)^t}$$

where W_t is the wage in the year t, C the direct training cost, MP_t the marginal product in year t, r the discount rate, m the number of years that trainee will remain employed, W_o the wage during training, and MP_o the marginal product during training.

One interesting implication of the above rule is that in a competitive labor market a firm should never invest in general training - training that can be used by other firms - since the firm cannot pay less than the employee's full marginal product without losing him to a competitor. Hence the above rule implies that a firm generally should not absorb the costs of graduate training by an employee.

The military organization, however, can hardly be described in terms of the competitive labor market. The military structure, most notably the hiring, promotion, and retirement procedures alters the above decision rules in very significant ways (Hanushek, 1973).

Entry into the military (with very rare exceptions) occurs at only two points: the lowest level of either officer or enlisted ranks. Upon entering the military the recruit (both officer and enlisted) is committed to remain for a minimum period - about four years. Promotion is linked very closely to seniority with little variance in any year group. Finally the personnel system is strongly influenced by the nonvested military program for retirement: if an officer serves at least 20 years he can retire at one half his highest pay; if he serves less he is entitled to nothing at all. Each of these attributes tends to insulate the military manpower pool from traditional competitive labor-force pressures and, as a result, tends to alter the standard investment rules (Hanushek, 1973).

The military sends officers to both civilian universities and its own resident schools for graduate education. While in school, officers are paid full military salary and have no duties other than attending class. But while graduate education could certainly be described as general training, usuable elsewhere, the officer is committed to remain in the armed forces for a certain period. Thus competitive pressures of the labor market, which under ordinary circumstances would not allow for any difference between wage and marginal product, are eliminated by contract for a period of time. In addition, some economists feel that the nonvested retirement system allows a divergence of current wage and marginal product, although not with certainty. Thus a modified decision rule for military investment in an individual has been developed by Eric A. Hanushek and looks as follows:

$$\sum_{t=0}^{N-1} \frac{(W_t + C)}{(1 + r)^t} + \frac{P' \cdot R}{(1 + r)^{s-1}}$$

$$= \sum_{t=N}^{I+3N} \frac{(MP_t - W_t)}{(1 + r)^t} + \sum_{t=I+3N+1}^{s-1} \frac{P_t (MP_t - W_t)}{(1 + r)^t}$$

$$= \sum_{t=N}^{I+3N} \frac{k_t}{(1 + r)^t} + \sum_{t+I+3N+1}^{s-1} \frac{P_t \cdot k_t}{(1 + r)^t}$$

where P_t is the probability of retaining an individual in period t, I the years of initial service obligation remaining, s the remaining years until retirement after training, P' the probability that the individual will stay in the service until retirement, R the expected present discounted value of retirement pay at time of retirement, n the number of years of school, and $k_t = MP_t - W_t$.

This equation considers sending an officer to school for n years. On the first line are two cost terms: the cost during the schooling period and the expected retirement costs. On the second line are the certain returns that accrue during the commitment period and the expected value of uncertain returns which cover the period after committed service and before retirement. The military should invest in graduate training if the expected value of the last line is greater than or equal to the expected value of the first line.

A significant feature of this equation is its inclusion of retirement costs. Recent studies have indicated that for many officers a deciding factor in their decision to remain in the service until retirement has been their selection to postgraduate school. Officers who might otherwise have left the service after their initial commitment was up now remain to retirement and thereby gain substantial benefits. It seems appropriate, therefore, to include some retirement cost as a factor in the equation. When one considers the alternative of replacing military officers, who might otherwise gone on to school, with civilians, there can be little doubt that inclusion of retirement costs is appropriate.

There are, however, some limitations of the equation which should be noted. It has to be pointed out that there is the limiting case where the military retains a constant number of personnel for the entire force, so that a decrease in graduate trained retirees is automatically compensated for with an increase in non-graduate trained retirees. In such a situation total retirement costs are a fixed cost and no retirement term should be included in the equation. A second limitation of the technique for estimating the returns to total investment in postgraduate education is that the estimates are only accurate to the extent that the graduate and non-graduate degree holders are alike in all respects except formal education. National samplings, however, seem to indicate that those with PhDs and MAs (military or not) are generally brighter (in measured academic performance) than those with BAs. The results obtained from the use of the above equation are uncorrected for these differences - if in fact they exist. Any estimates of returns thus are biased upward to this extent (Dodge and Stager, 1972).

However, despite these limitations and others to be mentioned later, the above equation remains a handy tool for deriving information about graduate education in the military. For any group of officers (categorized by such criterion as whether or not they receive flight pay, number of years in service, whether they are regular or reserve officers) all elements of the equation are known except the k_ts.

The quantity k_t is usually called the "productivity differential" and is the amount by which the trained officer's marginal product must exceed his current salary in each year that he remains in the service in order for the training investment to pay off.

Obviously there are many different values of the productivity differential that will satisfy the equation for the same W_ts and C. Therefore, calculations can be greatly simplified if one assumes a constant value for the differential over time, i.e., $k=k_1=k_2=...k_t$. In other words assume the military gets the same "productivity bonus" for each year that the individual trained officer is in the service.

This assumption can lead to some criticism since it can be argued that a larger differential immediately after schooling makes more sense since there is a rapid change of knowledge in most disciplines, and knowledge learned today will not be as valuable tomorrow. On the other hand, others

argue that increased experience implies a larger bonus over time. At present there is insufficient data to verify either claim (Dodge and Stager, 1972).

It seems reasonable to assume, therefore, that the differential can be held constant over time. Furthermore, with this assumption it is straightforward to calculate the constant, or average, differential which must be maintained throughout an officer's career in order for the investment in his education to be reasonable.

Comparison of Investments:

As mentioned earlier, the military is justified in sending officers to graduate school if the benefits exceed the costs of training. The training costs can only be recovered if schooling raises the officer's productivity above his salary so that he is paid less than his contribution to the military, or less than his "marginal product." While it is often difficult to measure marginal product, using the equation shown earlier it is quite possible to calculate the increase in annual productivity needed to warrant a schooling investment - the productivity differential (Lindsay, 1972).

Hanushek has calculated productivity differentials for each year of completion of graduate education up to 20 years of service; for categories partitioning officers into decision groups (regular flying, regular non-flying, reserve flying, reserve non-flying); for discount rates of 5 and 10 percent; and for one, two, and three years of schooling. The data used in the calculations were as follows: Wage rates were base pay as of July 1970, unadjusted quarters and subsistence allowance, estimated tax advantage, estimated medical benefits, and estimated benefits from commissary and exchange privileges (these estimated benefits are computed yearly by the Department of Defense in order to arrive at a "true" military wage). Costs of graduate education in civilian schools, C, were calculated on the basis of $31.70 per week or $1648.40 per year (these costs are reported on Stephen W. Chapel and Robert C. Wilburn, "Cost-Benefit Analysis of AFIT Advanced Education," AF/DPXY-70-002 Directorate of Personnel Planning, HQ USAF, Washington, D.C., August 1970). Retention probabilities represent the average percentage retained between 1964 and 1967 of individuals with advanced degrees in a given year group, regular or reserve, flyer or non-flyer. It should be noted that these figures probably underestimate the retention probabilities because of the depressed civilian labor market that exists today.

Retirement costs were calculated assuming average life expectancies as figured by the U.S. Bureau of Census (the same discount rate of 5 or 10 percent was used in retirement pay calculations). Initial service commitment was set at four years (Hanushek, 1973).

Given the above data, annual productivity differentials can be calculated for different classes of officers, and comparisons of the differentials make it possible to analyze different decision rules for selecting candidates for graduate school. A smaller differential for a given length of schooling implies that the probability of any investment being "good" is larger; that is, the probability is greater that the schooling investment will increase productivity sufficiently to cover costs. This, of course, implicitly assumes that the expected increase in marginal product from a given amount of education to be the same for each age - rank category. An alternate assumption would be that lower percentage increases in marginal products would indicate higher probabilities of recouping the investment (Hanushek, 1973).

Utilization of Training:

The probability of sufficiently increasing productivity through schooling depends upon the utilization of military officers who have been sent to school. It could be argued that graduate education, no matter what the field, increases the productivity of an individual at any given job - say commanding an infantry unit in the Army or commanding a ship in the Navy. However, it would be absurd to carry this argument to the point of saying that an individual's marginal product is increased by the same amount, regardless of the match between job and field of specialization. Presumably an individual's marginal product is raised most effectively when he works in his field of specialization (Johnson and Stafford, 1973).

The General Accounting Office surveyed a number of military installations in 1970 to ascertain the utilization rates for officers with advanced degrees. At the 14 installations visited, 68 percent of such officers were assigned to positions that did not call for an advanced degree. Further, of the positions that did require advanced degrees, only 23 percent were filled by officers with a masters degree or higher (General Accounting Office, B-16558, 1970).

The General Accounting Office also found that utilization policies vary by military department. The Army determined that an officer could spend up to 37.5 percent of his total service time in positions validated as requiring a graduate degree "without harming his career." The Navy officer could expect an average of 1.4 two- or three-year tours in his specialty. The Air Force tour policy calls for more utilization.

The utilization of officers with advanced degrees affects the interpretation of the calculations of product differentials. First, the costs of schooling and maintaining an officer with graduate education were amortized over the officer's remaining time in service. Therefore, if the officer uses his schooling for only a portion of his service, the calculated productivity differentials understate the true values. Second, both the stated utilization policies of the services, and their actual assignment of personnel indicate that utilization is likely to be greater at lower years of service, implying that young officers are an even better choice for schooling than previously suggested.

Civilian Comparisons:

The productivity differentials shown earlier represent the current and future costs of obtaining an officer with graduate schooling: the productivity differential plus the pay upon leaving school are the "effective salary" of an officer at completion of graduate schooling. The total annual costs for a newly trained officer must be compared to salaries paid to entering and experienced civilians with graduate degrees. Presumably, if a civilian could be obtained at a cost less than the effective salary of a graduate officer, the civilian should be hired and one less officer should be sent to graduate school.

Consider, for example, a non-flying Navy lieutenant (O-3) completing two years of graduate training at the end of 5 years of service. His pay is $15,434 per year. The Defense Department has recently issued a statement saying that fringe benefits such as "a free retirement plan, government furnished housing, medical and dental care, and discount food and merchandise in commissaries and exchanges" adds 28.5 percent to military pay. Accepting this to be true for a moment, that would bring a lieutenant's pay to $19,834. The calculated productivity differential is approximately $4,700. This brings the "effective salary" of a lieutenant having just completed graduate school to $24,533. The argument then is that if the military could

hire a civilian with a graduate degree for a salary (plus benefit costs) of less than $24,533 they would be saving money. And $24,533 can be considered an understated salary figure because in fact the average officer going through two years of graduate school has more than 5 years in service at the completion of his program. A lieutenant commander completing two years of graduate education in his tenth year of service has an effective salary of over $30,000 per year.

Using such statistics, and an annual salary of $16,000 for a civilian federal worker with a masters degree, the General Accounting Office has calculated that the Navy will incur an additional $50 million in costs for procuring a like number of graduate degrees through military programs as opposed to civilian hirings. When one considers a figure three to four times this amount for the entire armed services it quickly becomes a substantial amount of money. Yet are such figures entirely accurate? Perhaps not.

The figures and formulas presented so far and the General Accounting Office's reasoning depend to a substantial degree upon "true" military pay as compared to civilian pay. This can lead to a serious criticism of the foregoing analysis. Namely, the faulty comparison of military and civilian pay.

As mentioned earlier, the Department of Defense (and the General Accounting Office) have stated that fringe benefits add roughly 25 percent to military pay - about 10 percent for housing, 3.5 percent for medical care, another three percent for commissary and exchange privileges, 8.3 percent for retirement benefits and 3.7 percent because these benefits are not taxed.

But then it says that its military pay computation was based on base pay "plus allowances for quarters and meals."

Unmentioned was the fact that not everyone gets government furnished quarters - and when they do, the quarters allowance is forfeited in return. This makes up 10 percent of the 28.5 percent benefits package - and it can not be counted both ways, as a part of base pay and as a percent of the benefits package.

Another big item in the benefits picture drawn by the Defense Department is the "free" retirement system.

Anyone familiar with the history of military pay will recall that the retirement factor has an "imputed" value of 7 percent of base pay - that is, Congress has consistently set military pay scales with 7 percent "withheld" because the government paid the costs of the military retirement system.

This, of course, takes it out of the "free" category - it is a benefit which reduces the amount of take-home pay a military person gets, just as the retirement deduction taken out of a civil service employee's check - also 7 percent - reduces his available cash.

If the military pay figure is increased to account for the imputed retirement deduction, then it would be only fair to increase civilian average pay to account for their noncontributory systems. The trouble is, the amount would depend on statistics not available: how many such systems there are and how generous the company subsidized benefits are.

Therefore, it seems reasonable to suggest that some or all of the military retirement fringe benefit is equaled in the civilian sector by either free coverage, or by more generous annuities, or both.

So there goes another 8.3 percent of the military's 28.5 percent benefits package. The package is now worth only 10.2 percent - 3.5 percent for medical care, 3 for commissaries and exchanges and 3.7 for the tax-free nature of these benefits.

Ten percent is pretty good, one might say. But then one has to remember that the Defense Department has decided that commissaries must be self supporting so, if Congress agrees to that move, it will wipe out a decent portion of that 3 percent.

And there could be some interesting discussions concerning medical care. Combat wounds, for example: Is treating them to be considered a "fringe" benefit?

All in all, it looks like there might be only 8 percent of that big "benefits" package left (Navy Times, March 26, 1975).

The Defense Department has maintained for several years that military and civilian salaries are comparable. Therefore, the Defense Department goes on to say, because of the benefits package, the average military man makes

28.5 percent more than his average civilian counterpart. We have just seen that figure reduced to 8 percent.

However, something has apparently been forgotten - civilian workers get fringe benefits, too. And according to a recent study by the U.S. Chamber of Commerce, those benefits in 1973 - the latest year for which figures are available - averaged 35 percent of the average civilian wage as computed by the Commerce Department and apparently accepted by the Defense Department!

Yet not one word from the Defense Department even hinted that there were such civilian fringes, even though the big theme these days is comparability of pay.

During recent hearings before the Senate Armed Services Manpower Subcommittee, Senator John C. Culver angrily exploded, "Surely security of employment should count for something, shouldn't it?" (Navy Times)

Certainly it should. And surely, on the other side of the coin, employment freedom should count for something, too. Most civilians can go home to their families every night. And if they don't like their boss or their work, they have the freedom to shop around for something else to do or somewhere else to work.

Military people can't do these things - and it was partially to ease the problems brought on by these restrictions that the military fringe benefits were originally created. These are the intangibles that can not be put into figures and statistics, but they must not be forgotten.

In light of the foregoing analysis, then, it seems reasonable to assume that there is not a great deal of difference between the real cost of hiring a civilian with a graduate degree or sending a military officer to graduate school. At the very least, it is necessary for the General Accounting Office to recompute its figures concerning such costs.

It should be noted that despite the above analysis of pay comparisons, the decision formula presented earlier in this paper for training investments in the military remains a valuable tool for comparison of intra-military training.

Summary:

In conclusion, then, what can be said about graduate education in the military? First, that the armed services are indeed probably spending far too much money on graduate training. This could certainly be alleviated by a realistic reevaluation of the jobs requiring an advanced degree with the goal of eliminating as many as possible. Second, a policy of heavier utilization of officers with advanced degrees should certainly be adopted. Third, a reevaluation should be made of which officers are to be sent to graduate school. We have seen that younger officers with fewer years service time are much better training investments than older officers.

Other policies are also possible: the military could offer a bonus to individuals with graduate degrees if they would join the service - much like that presently offered to doctors. Or, conceivably, the military could make officers pay for a portion of their graduate training.

One thing seems certain: there will always remain a need in the military for graduate trained officers. And, considering the present mood of the Congress, it is in the best interest of the military to take a hard look at their present policies with the view of cutting costs as much as possible. If they don't, the Congress will and that could be disastrous.

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Entropy As A Managerial Concept

By D. K. Wallace

This paper is not concerned with the mechanics of organizational improvement; it is an attempt at understanding an organization as another interactive, microcosmic melieu where people, like particles, react to collisions with one another. For background material the writer draws heavily on his own training in chemisty and physics.

This paper was submitted to Commander McGonigal for Organizational Behavior and Administration (MN 3125).

Introduction:

In Chemistry we are able to predict how substances will interact with each other and what new substances will be formed. In management science there seems to be a great deal of disagreement among researchers about what will result from the interactive process within the organizational test tube. Perhaps if we draw parallels between human systems and physical systems we can use the so called laws of science to aid us in determining the outcome of organizational reactions.

The second law of thermodynamics is examined herein and a comparison made to the entropy of closed physical systems and that of closed organizational systems. The terms competency and efficiency are used frequently in the paper. We say that an organization operates competently when it achieves its objectives, maintains its internal environment and is able to adapt or retain control over the relevant internal environment over the long run. Effectiveness is measured by how well the organization handles these things in any given situation. Organizational entropy is measured as an inverse function of these attributes. In other words, noticeable entropy has set in when the organization begins to fall short of the requirements for competence and effectiveness.

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Entropy for Managers:

Thermodynamics is the study of the laws which govern processes which involve changes in the energy possessed by a system by virtue of the motion of the atoms and/or molecules within the system.

There are three laws basic to an understanding of thermodynamics:

1. In a system of constant mass, energy can be neither created nor destroyed.
2. The entropy of a closed system increases with time.
3. The temperature of a body can never reach -459.69°F the point where all molecular motion ceases.

We are concerned with the second law and this concept named entropy. Initially entropy was a fabrication of physical scientists to facilitate calculations and explain certain experimental phenomena confronted in the study of closed system processes. Unless we intend to perform these calculations or derive data from experimentation it is only necessary to understand entropy as the degree of disorder of the participants in the system. By the second law of thermodynamics we know that the total disorder of an isolated system must increase if the system processes are irreversible. One depressing aspect of this concept is that if one considers the whole universe as a closed isolated system then it is doomed to one day unwind itself as all energy is converted from some useful form to some useless form and the particles within the universe are in a state of complete disorder.

Suppose we were to view an organization as a closed system and postulate that participants interact with one another - if not in the mindless manner of molecules perhaps they are subject to the same laws of interaction. Does not every interpersonal action result in some repondent reaction among those effected? Have we not seen once vibrant, exciting organizations wind down into a muddle of bland mediocrity or fail altogether?

Organizational Entropy:

If we view the lessening of organizational effectiveness and competency as the criteria for increasing entropy then in what types of organizations are these attributes present and in what degree? Argyris sees these factors as maintained at

a constant level in organizations where problems solved are routine in nature, the information required to make decisions is minimally threatening to the organizations' participants and no internal commitment is required of the decision maker or problem solver. In contrast the entropy level will tend to rise where problems require innovative solutions, data and information required is a threat to the decision participants and an internal commitment is required.

An organizational system can be further dissected into levels of participation which display either routine or non-routine task performance, varieties of information requirements, and differing levels of commitment.

The Lower Level World:

If we look into the lower level work what are its characteristics? As typified by the mess decks and to a lesser degree as we ascend the pyramid of the lower level we find that:

1. The work is highly specialized and fractionalized (Server, Jack-of-the-dust).
2. It is believed that the simpler the task:
   a. The shorter the training time required.
   b. The more work that can be done.
   c. The greater the ease with which personnel can be interchanged.
   d. The greater the satisfaction due to less frustration and less responsibility.
3. Responsibility for planning the work, how to do it and what to do lies in the hands of managment not ordinarily in the hands of those actually producing.
4. Changes in the lower level world are controlled by top and middle management. For example, the prescribed length of a man's hair is determined by the CNO and this policy is implemented with great vigor by top and middle management.
5. Evaluations of performance, rewards and punishment are in the hands of management.

The result of this structure are:

1. For the most part the abilities of the worker that are utilized tend to be more of the physical variety, muscle power, manual dexterity, etc.

2. A high degree of submission an dependence toward superiors results because that is where the control over his life and world reside.

3. Because he is told what to do and when to do it, the worker tends to take less and less responsibility for his own actions.

4. Behavioral scientists believe that as his outward submission and dependence increase, his inward response is one of antagonism and psychological withdrawal from the organization. This inner antagonism is made visible when it results in:

   a. Unauthorized absenteeism.
   b. Requests for transfer.
   c. Hostility toward authority.
   d. Gold-bricking and indifference.
   e. Asocial activities.

Interestingly left to its own devices management's response to these symptoms is usually more control, tighter regulations clothed at times in the clever disguise of human relations programs all of which appear to result in more frustration, further internal and external antiorganizational activities and self-maintained feedback system of recursive disintegration.

The growth of control at higher and higher levels has even been institutionalized into what we call the systems approach were management by definition plans and controls human effort and the effectiveness of this effort is monitored by exception reports. Unfortunately the life blood of the system is information and data and is therefore susceptable to poisoning by distortion of data and neutralization of information at the lower level.

The Higher Level World:

In a pyramidal organizational structure power to change the system is vested at the top. There is less contrived control and more freedom to innovate than at the lower level. The biggest obstacles to constructive change are the interpersonal relationships and the traditions of the organization. The more innovative the manager, the more risks he is expected to take in his decision making, the more threatening the information he deals with the higher the probability that his actions will violate the traditions of the organization or generate conflict among its members.

It is at the top that entropy takes its most malignant form. Executives, who should be worrying about insuring the effectiveness of their subgroup, have assigned themselves the task of "getting the job done" thus drawing control and attendent responsibility to themselves.

The elements of position role playing also come into play, for example, if a personality conflict is affecting intergroup relationships among managers the participants are urged not to deal with the conflict by venting their emotions. Quite the contrary, anytime interpersonal conflicts begin to be voiced at a meeting of managers the old edict of "let's leave personalities out of this and get back to relevant issues," is emitted by some well meaning conciliator.

Argyris states:

> "As the interpersonal and emotional aspects of behavior become suppressed, we may hypothesize that an organizational norm will tend to arise that coerces individuals to hide their feelings. Their interpersonal difficulties will be suppressed or disguised and brought up as rational, technical or intellectual problems."[1]

The fear of violating the traditions of the organization have just as dysfunctional as effect if they prevent the flow of honest information up and down the organization, if it causes executive minds to be closed to new ideas and changes in values, if it prevents a manager from taking the risks inherent to a vibrant stewardship, or from daring to own ideas. The insidious "play it safe" philosophy rears its head in this environment and the "safe" individual contributes to the peril of the organization dying from within of atrophy.

Given that a manager falls into the trap of conforming to the norms of the organization to the expense of his innovative abilities and to the degradation of his charismatic image it is understandable why his subordinates will be unable to form an internal commitment to the organization thru him. At best, all he can inspire is a weak external commitment based upon a loyalty inspired by the power of the manager to dispence rewards and punishments.

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[1]Chris Argyris, Intervention and Theory and Method: A Behavioral Science View, (Reading, Mass: Addison-Wesley Publishing Co., 1970), p. 65.

Soon everyone is on the defensive and organizational competence and efficiency become lost under the collective security blanket. Unfortunately an organization in this mode soon begins to feel pressures it did not notice before because it was full of energy and in motion, now it is winding down and sensitive to each intrusion on the daily routine.

Seemingly, a crisis situation is required to cause managers to act like executives again; knocking down social and interpersonal obstacles, assisting other departments, wisely allocating available resources to the correction of the problem, encouraging the participation of subordinates, venting emotion if task accomplishment is not forthcoming -- in short, acting in the manner which adds vibrancy to the organization, substance to his position as leader and inserts energy into the organization.

What of subordinates? They probably see the inconsistency in management's day to day characteristics and its demeanor when reacting to crisis and though they too probably delight in watching the organization function effectively, the constant starting and stopping of the organizational machinery soon becomes tiresome and they begin to be apathetic about periodic crisis tending to try to insulate their area of concern from the ravages of crisis. Once again, reinforcing the self-protective mechanism at the labor level that was seen to be dibilitating at the management level.

It would seem obvious that if the organization functions relatively well during a crisis that the level of energy expended during crisis management would be appropriate and curative as a routine.

In a physical system since energy can be neither created nor destroyed we can see how the reversal of the entropy process is impossible, but in an organization surely men with a free will can just decide to expend the extra energy required to correct organizational ineffectiveness! Unfortunately, men of free will are also creatures of habit and the tendency to informally institutionalize ways of doing tasks without regard to their relative merit is an all too frequent tendency in organizations. Hints that this is happening lie in statements such as: "...but that's the way we've always done it" or the glib "there's the right way, the wrong way and the Navy way."

Perhaps lying closer to the inability of the system to correct itself is another phenomenon closely related to a physical concept -- that of inertia. Inertia is defined in classical physics as the tendency of a body to preserve its state of rest or uniform motion in a straight line. Exper-

ience shows that organizations and groups of individuals in general who have acquiesced to organizational norms are quite resistant to change more so than an unaffiliated individual.

To those members of the organization who have traded their right to take constructive risks in the organization for safe anomality the thought of change invokes fear and trembling.

An ironic aspect of this characteristic resistance to change is the manner in which attempts at altering the system are implemented.

The first step, once the change has been formulated into a policy, is a compulsive urge for management to hard sell the policy to subordinates. The worst mistake being the old "that's the way the Admiral wants it, guys" and "I don't like it any more than you do, but that's the way its going to be." Somewhat more subtle but just as dysfunctional is the condensending "you may not see the need for this change now, but give it a chance and I'm sure you'll come around." Both of these methods presuppose that subordinates will not agree with the policy change and give the impression of defensiveness on the part of the manager or worse, that the manager is passing the buck. Intelligent discussion of the policy change precluded by the very atmosphere of its presentation and openness in any discussions that do come forth is inhibited by the fear that management is uneasy about the issue. All of this pushing down from above and resistence from below is contributing to the growth rate of the entropy level.

The question arises that if management's methods and behavior contribute so heavily to system disorder why don't they, as well educated rational men, alter their own behavior to be more functional? The answer to this is that self evaluation is a rarity in western man and the finding of fault in one's self is much more difficult than finding fault in others.

To illustrate this tendency toward managerial blindness Argyris reports that:

> "In a study of top executive committees (who) described their relationships with their subordinates as good to excellent. When asked how they judge their relationship, most of the executives responded with such statements as, 'They do everything that I ask for willingly,'

and, 'We talk together frequently and openly.'"[2]

The subordinates' view was quite different. Top management would have been surprised to learn that in the reported study that:

1. Seventy-one percent of middle managers did not know where they stood with their superiors.
2. Sixty-five percent did not know what qualities led to success in their organizations.
3. Eighty-seven percent felt that conflicts were very seldom coped with, and that when they were the attempts tended to be inadequate.
4. Sixty-five percent thought that the most important unsolved problem of the organization was that top management was unable to help them overcome the intergroup rivalries, lack of cooperation, and poor communications.
5. Fifty-nine percent evaluated top management's effectiveness as not too good or about average.
6. Eighty-two percent wished that the status of their functions and jobs could be increased but doubted they could communicate this openly to top management.[3]

With this natural tendency toward system entropy so much a part of organizations, why don't we see them crumbling about us with greater frequency? The answer to this lies in the fact that there are some attributes of some of the participants in the organization which retard entropy and indeed can cause it to remain constant. These factors include:

1. The latent talents and abilities of the organizational membership provide a fountain of solutions to ineffectiveness when a dire need arises.

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[2]Chris Argyris, Organization and Innovation, (Homewood, Ill: Irwin, 1965), pp 61-91.

[3]Chris Argyris, Organization and Innovation, pp. 61-91.

2. Some of the members at all levels have a high internal commitment to the organization which makes up for the lack of contributory energy on the part of others.

3. Some of the attempts at change are so obviously necessary that they need not be oversold and are easily digestible throughout the structure.

4. The most powerful catalyst for entropic reactions are the flow of threatening data in the communication channels, non-routine tasks and innovative and risky decision making. The vast majority of day to day activity deals with fairly routine tasks and non-threatening information which have only a microscopic influence on system disorder.

5. In the Navy we have the benefit of an occasional war to light fires under the participants. Petty rules and regulations take a back seat to task accomplishment and the human machinery miraculously starts to hum again as crisis management molds itself into creative, courageous, and innovative management.

6. In contrast to the halting of the entropy process in war time is the slowing down of the process when peace time turns to economic hard times and dependence and submission to the organization become more internally acceptable and inspire a moderate drive to maintain the existence of the organization rather than be without any organization at all among a majority of the participants.

Conclusion:

In extending the concept of entropy to organizations it is easy to fall into the trap of predicting doom for all organizations just as we can predict the ultimate death of the universe as it winds down to steady state. The saving point is that the concept of entropy depends on having a closed system where no new source of energy is allowed to reorder the system. Being aware of the entropic forces acting within the system and being alert to the symptoms of management by crisis, destructive and unresolved intergroup and/or interpersonal conflicts and the preference for safe decision making and ineffective problem solving should trigger a response by management to open the system. Just

what is let in to recharge the system is beyond the scope of this paper except that good scientific procedure would involve a consideration against contamination of the system during the procedure.